Volume 5. MARCH, 1891. $2.00 a Year.
Number 3. 75c. a Number.

JOURNAL

OF THE

New England Water Works

ASSOCIATION.

ISSUED QUARTERLY.

PUBLISHED BY
BOARD OF EDITORS.
Junior Editor's Office, 113 Devonshire St., Boston, Mass.

Entered at the West Newton Post-Office as second-class matter.

OFFICERS

OF THE

New England Water Works ASSOCIATION.

1890-91.

PRESIDENT.

ALBERT F. NOYES, City Engineer, West Newton, Mass.

VICE-PRESIDENTS.

GEORGE P. WESTCOTT, Treasurer Water Company, Portland, Me.; CHARLES K. WALKER, Superintendent, Manchester, N.H.; F. H. CRANDALL, Superintendent, Burlington, Vt.; PATRICK KIERAN, Superintendent, Fall River, Mass.; WILLIAM B. SHERMAN, Civil Engineer, Providence, R.I.; W. H. RICHARDS, Superintendent, New London, Conn.

SECRETARY.

R. C. P. COGGESHALL, Superintendent, New Bedford, Mass.

TREASURER.

HIRAM NEVONS, Superintendent, Cambridge, Mass.

SENIOR EDITOR.

F. H. PARKER, Commissioner, Burlington, Vt.

JUNIOR EDITOR.

ALBERT S. GLOVER, West Newton, Mass.

EXECUTIVE COMMITTEE.

FRANK E. HALL, Superintendent, Quincy, Mass.; DEXTER BRACKETT, Superintendent, Boston, Mass.; CHARLES W. MORSE, Superintendent, Haverhill, Mass.

FINANCE COMMITTEE.

H. F. WHEELER, Registrar, Lawrence, Mass.; G. E. WINSLOW, Superintendent, Waltham, Mass.; F. A. ANDREWS, Assistant Superintendent, Nashua, N.H.

Rockwell and Churchill Press, Boston.

Table of Contents.

	Page
Election of Members	101
February Meeting, 1891	109
January Meeting, 1891	101
Papers and Discussion:	
"Driven Wells as a Source of Water-supply." By F. F. Forbes, Superintendent, Brookline, Mass.	141, 142
Discussion by Messrs. Brackett, Holden, and the President	142–144
"Main Pipe, An Experience in Crossing a Stream with a." By E. H. Gowing, C.E.	135, 136
Discussion by Messrs. Holden, Ball, Brackett, Jones, and the President	136–140
"Main Pipe, An Experience in Moving." By W. E. Davis, Superintendent, Sherburne, N.Y.	125, 126
Discussion by Messrs. Hawes, Jones, Forbes, and Allis	127–129
"Soft Answer, The." By L. H. Gardner, C.E., Superintendent, New Orleans, La.	129–131
"Storage, Effect of, upon the Quality of Water." By F. P. Stearns, Chief Engineer, State Board of Health of Massachusetts	115–123
Discussion by D. FitzGerald, C.E.	124, 125
"Water Mains, The Care of, in Relation to the Quality of the Supply." By George F. Chace, Superintendent, Taunton, Mass.	131–134
Remarks of Mayor Alger, of Cambridge	102
Remarks of Mayor Mayberry, of Waltham	102
Topical Discussion	104

NEW ENGLAND WATER WORKS ASSOCIATION.

ORGANIZED 1882.

Vol. V. March, 1891. No. 3.

This Association, as a Body, is not responsible for statements or opinions of any of its members.

YOUNG'S HOTEL, BOSTON, Jan. 14, 1891.

The meeting was called to order shortly after two o'clock, P.M., by President Noyes.

ELECTION OF NEW MEMBERS.

The Secretary announced the receipt of applications for active membership, as follows: —

1. John D. Shippee, Secretary and Superintendent, Holliston, Mass.
2. George H. Barrus, Consulting Engineer, No. 95 Milk street, Boston, Mass.
3. William W. Starr, Civil Engineer, Bridgeport, Conn.
4. S. Everett Tinkham, Assistant Engineer, City Engineer's Office, City Hall, Boston, Mass.
5. Frank H. Mills, Civil Engineer, Woonsocket, R.I.
6. X. H. Goodnough, Assistant Engineer, State Board of Health, Boston, Mass.

It was voted that the Secretary be instructed to cast a ballot favorable to the said applicants, and, he having attended to that duty, they were declared duly elected members of the Association.

THE COMING CONVENTION AT HARTFORD.

After a song, "The Petrels' Cry," by Messrs. Monroe and Pratt, the Secretary read a communication from the Connecticut Association of Civil Engineers and Surveyors, transmitting a vote passed by the said association at a meeting in Hartford, Jan. 13, directing the president to appoint a committee to confer with the local committee of the New England Water Works Association and with the officers of the Association, and render them any assistance in their power to make arrangements for the coming convention of the New England Water Works Association in Hartford. A list of the members of the said committee accompanied the communication.

On motion of Mr. Brackett, the communication was accepted and referred to the Executive Committee.

The PRESIDENT. — Gentlemen, it always gives us pleasure at our meetings when we have with us the heads of our various municipalities. To-day we have

the gratification of having with us Mayor Alger, of Cambridge, and I would, in the name of the Association, request Mayor Alger to speak a few words to us. (Applause.)

Remarks by Hon. Alpheus R. Alger.

Mayor Alger said: —

Mr. President and gentlemen of the Association, I assure you that I did not know I should have the pleasure of saying a word to the members of this Association this afternoon. Had I been aware of that fact, I might perhaps have hesitated about putting in an appearance. (Laughter.) Owing to the courtesy of the Superintendent of the Cambridge Water Works, Brother Nevons, I have the pleasure of being with you to-day.

I assure you that I appreciate the hospitalities which have been extended to me, and am pleased to be with you and to meet the representatives of the boards of water works of the various cities in New England and the engineers who have them in charge.

Coming, as I do, from a no-license city, I should be supposed to know all about water (laughter), but, unfortunately, I am one of those who vote for license, and in the last campaign there were some remarks made to the effect that I knew more about other liquids than I did about water. (Laughter.) So I will not endeavor to say anything about that very healthful beverage.

But I came more for the purpose of listening and receiving information regarding the very important subjects that are placed in your charge. I know very well, and fully appreciate, the importance of such an association to a community or to the different communities which you represent. Such an organization cannot fail to be of great importance to the different localities, and it would be really profitable for the cities to maintain an association of this kind at their own expense, rather than to have it fail to be in existence.

Of course, if it were necessary, I might go into the different details wherein this organization is of great service, not only to the individual members, but, indirectly, to the different municipalities that the members represent. But I will not take up your time, Mr. President and gentlemen. You yourselves are fully aware of the importance of this organization, else it would never have sprung into existence.

Thanking you for the courtesy you have extended me in calling upon me for a few remarks, I will not detain the meeting by speaking at greater length. (Applause.)

The President. — Gentlemen, we have with us to-day the mayor of one of our younger cities, and I will introduce to the Association Mayor Mayberry, of Waltham. (Applause.)

Remarks by Hon. G. L. Mayberry.

Mayor Mayberry said: —

Mr. President and gentlemen of the Association, I came here with perhaps even a stronger impression than Brother Alger that I would not be called upon to make a speech, for at the time Mr. Winslow extended me the invitation to come here to-day, I distinctly put the question to him as to whether any speech-

making would be required, and he assured me that he had fixed that for me all right. I am afraid he forgot. (Laughter.)

I see that you gentlemen preserve your traits even here. I know there is a great deal said about water-rates, and I suppose this speech-making to-day is in the nature of a water-rate. (Laughter.) You don't propose to have anybody eat at your table without paying for it by a speech.

The President might have introduced me as "the young mayor," and, in fact, I suppose he could equally well apply the term "youthful" as well to the mayor as to the city. It is applicable in both cases.

As I have been in the office only a week, I don't know what the mayor's relation to the water board of Waltham is, as yet. What little I know about the water works I picked up in the year or two that I was solicitor there, when I had the legal questions concerning the department under consideration. I found that the great peculiarity of our water board — and I suppose it is so in most cities, but it is a very strongly-marked peculiarity there — was its great ability to ask questions (laughter), and some pretty hard questions, too, that it would take a pretty long while to answer. If I remember aright, the first question I got from the water board of Waltham, after I was elected city solicitor, was something like this: "Give us an opinion as to the extent, nature, and limit of the powers of the Water Board of Waltham in making contracts with customers." (Laughter.) Well, I thought that question over a good while. Finally I suggested that I thought my salary was hardly large enough to warrant my writing a treatise on the water works, and I asked them if they could tell me the specific case which was bothering them. I found that it was a very simple proposition indeed, when they got down to it. All that talk was just to find out what they could do in this case: they had put a pipe into a man's lot, with the understanding that he would grade it up high enough so that the water in the pipe would not freeze, and that he would do it before cold weather. They were contemplating an arrangement to stop the water if he did not do so, and they wanted to know whether they had the right to shut off the water before cold weather came if he did not do so. (Laughter.) The question, I may say, did not come from friend Winslow — I see he is getting a little nervous here. (Laughter.)

I will just give to you one more question, which was propounded to me while I was at work on my inaugural and just about to go out of the office of city solicitor. I suppose it was intended for a parting shot, and it was a pretty good one: "Can you tell us how far the Water Commissioners must go away from the river or pond from which they take their source of supply, to dig a well, in order to get water, without being obliged to pay damages to men who own mill privileges along the stream?" (Laughter.) Well, I didn't know whether that was an engineering question or a question of law. That question remains unanswered, and I have passed it over to my successor. (Laughter.)

The question did, however, come up in somewhat practical form as to whether we had a right to take water by well from land we had taken for water-work purposes, without paying damages and without going to the Legislature. That question I had occasion to consider, and I found it was well settled by the authorities that you could take water from the tributaries of a river, — the sources of supply of a river, — the same as from the river itself, under the meaning of the law.

Now, I don't know that I can give you any information in regard to water works. I have been in the habit, as I say, of looking at questions connected with this subject from a legal standpoint, and I come here, like my brother Alger, to get information in regard to the subject and not to give it. I thank you very much for the hospitality you display here, and I will listen with a great deal of interest to the communications which are to be read. (Applause.)

Messrs. Monroe and Pratt sang "The Forest Birds."

Mr. F. P. Stearns, Chief Engineer State Board of Health, then read a paper entitled "The Effect of Storage upon the Quality of Water."

Questions Propounded.

The President. — Since the last meeting the following questions have been sent in to be presented to the Association at this meeting, with the request that such members as may have had experience in the matters referred to will answer them. The first question is this: —

"Supposing, after report by a superintendent of water works, duly setting forth that certain localities containing factories and thickly settled districts are poorly protected from fire, or practically unprotected, owing to pipes being quite too small, and recommending immediate attention, that a fire breaks out and the property is destroyed by reason of failure of the fire supply, say one year after such report, would not the city be held for damages, owing to such inadequate fire protection?"

The second question is this: —

"Is it practicable to build filter-galleries for artificial filtration on the borders of ponds furnishing water-supply to a community where gravel is scarce and where rocks full of fissures form the rim and basin of such ponds, and where the water in the pond when full is none too high to furnish gravity pressure, and in times of drought there is a change in level, say as much as seven feet?"

The third question is: —

"What is the cost, approximately, of building and maintaining a large artificial filtering gallery sufficient for, say, 1,000,000 gallons per day?"

I present these questions to the Association and trust that there are some members here who may be able to answer them. I would be pleased to hear from any members of the Association. When the question which I read first was presented to me I cast about in my mind to see where there were works where this question might practically have come before the commission, and I took the liberty of addressing the question to Commissioner Hawes, of Fall River. Perhaps since receiving it he may have recalled facts in this connection which may have come to the attention of his commission.

Mr. Hawes. — There it is, gentlemen; Fall River in the gap again. (Laughter.) If there is any question that hasn't occurred to us, gentlemen, you just suggest it. We would like it to occur before the next meeting, so that we can say something upon it. (Laughter.)

I never have been city solicitor of Waltham or of Fall River, but if I had been, and if these questions had been presented to me, they might have assumed a much more portentous shape than as at present propounded (laughter) —

especially if they had been written out in the language of Brother Winslow. (Laughter.)

But there is considerable involved in this first question, and I think the man who put it in must think that this Board is a pretty wise sort of an institution to be able to answer it. The question reads: —

"Supposing, after report by a superintendent of water works, duly setting forth that certain localities containing factories and thickly settled districts are poorly protected from fire, or practically unprotected, owing to pipes being quite too small, and recommending immediate attention, that a fire breaks out and the property is destroyed by reason of failure of the fire supply, say one year after such report, would not the city be held for damages, owing to such inadequate fire protection?"

Well, yes, they could, — but let us see you get them. (Laughter.) Gentlemen, you have all been boys, and you know when anything happens to a boy he always turns round to see who to blame. You all know, also, that when you are driving a nail and pound your finger, the first thing you do is to lay it to either the nail or the hammer. (Laughter.) But there is no one to blame but you — you are the man. Well, there is a responsibility in such a case as is involved in this question that rests upon somebody. Now, who is it? In the first place, it may be that when the city or town put in their water works, the pipes were considered adequate for all needs which they ever supposed they would want to have supplied. The town or city may have subsequently outgrown the system originally introduced, and may require larger pipes to protect the property. We had a case in our city, when we put in our water works twelve or thirteen years ago. We had original plans for 24-inch pipes coming down direct from the water works. The plan was to connect across for about three thousand feet, with 24-inch pipes; but in laying down the pipes we came to a large cross street that is quite well populated, and we put a 12-inch pipe across and connected the 24-inch pipes with a 12-inch pipe. After that, later, we went across at another street, connecting a 6-inch pipe on to that 24. Well, that exhausted about all the funds we could get and all they would let us have, and we kept putting it off from one year to another. Every year in our report we would recommend that a 24-inch main be laid across Eastern avenue; that at the Tremont-street and Eastern-avenue connections with Bedford street, instead of having 12 and 6 inch pipes, there should be 24-inch pipes. It got pretty serious. We kept making our recommendations stronger, until, I think three years ago this month, the mayor and aldermen when making up their appropriations called the water commissioners before them. At that time we couldn't stir them. In the meantime, by the way, between the time when the water had been introduced and this time I speak of, some nine or ten years had elapsed, and in the section supplied by these smaller pipes factories had been built, dwelling-houses had been erected, and the population had increased very largely. Finally, after we had exhausted all the arguments, I said: "Gentlemen, if I had a factory over in that quarter, and you had pretended to sell me water, or supply me with water, to protect me against fire, and a fire should occur and your pipes should give out for want of sufficient supply, I would turn around and sue this city for damages, and I think I would get them." That set them to thinking pretty lively. They immediately appropriated $20,000, and the next year 24-inch pipes were

laid clear across, so that our connections were complete, and we haven't got to test the question to find out whether the city would have to pay damages in case a fire occurred and the water-supply should be inadequate, or not.

But if a railroad in building its road builds it for the original traffic it expects on it, and does not build its bridges heavy enough, and by and by there is big travel on the road, and where they had formerly run two cars they are obliged to run ten or twelve cars, loaded with passengers, and some day the bridge comes down, the railroad has to pay the damage. They pretended to accommodate the public, and took pay for accommodating them, and, of course, in such an event they have to pay large and serious damages. Now, if a town or city lays its water-pipes, and after the city or town has been growing awhile they are notified by the superintendent of water works that the pipe is not sufficient to protect the inhabitants in certain localities in case of fire, it looks to me as though there was responsibility there, and that if there was any damage to any parties by reason of there not being a sufficient water-supply in case of a fire, that those parties could come on to the town or the city and claim damages. But when you come to get these things into the courts, then these city solicitors get hold of them, you know, and they pull one end, and the other fellows the other, and you don't know who is coming out ahead. (Laughter.) So we cannot tell you whether the city or town is responsible, but we can tell you what we think about it, and I think there should be some responsibility that would force a city to put in mains large enough — if they were not laid large enough at the first start-off — for the requirements of the city. (Applause.)

The PRESIDENT. — In casting about as to who of our members could give further information on these questions, I was led to look about to see who of our constructing engineers probably had as varied an experience as any in our Association, and my thoughts immediately turned to Mr. Tidd. I felt that possibly he, in reasoning before the various committees whom he has had to meet, might have brought these questions forcibly before them, answering one or all three of the questions. I would call upon him at this time and ask him if he can give us the result of his experiences. (Applause.)

Mr. TIDD. — Mr. President, in relation to the first question, which Brother Hawes has enlightened you upon, if my opinion was asked upon it I think I should say it was a question for the Supreme Court to decide. I suppose there would be a suit to recover damages by the party who lost the property, or if the loss was paid by an insurance company, it would be a question between the insurance company and the town or the city, and no one can tell where it would come out.

But I would like to refer to the second question: —

"Is it practicable to build filter-galleries for artificial filtration on the borders of ponds furnishing water-supply to a community where gravel is scarce and where rocks full of fissures form the rim and basin of such ponds, and where the water in the pond when full is none too high to furnish gravity pressure, and in times of drought there is a change in level, say as much as seven feet?"

I should say that this question is a very crude one, and may cover a very broad ground. You may say, in one sense, that it is practicable to build a filter-gallery on the top of the Rocky Mountains, but you certainly wouldn't get any water in it.

In this case, if I was going to take a water-supply from such a pond as is suggested here, with what little knowledge this question conveys, I should take the water from the pond and not build any filter-gallery. Rock is pretty poor material for filtering water. (Laughter.) Any filter I consider a strainer, and if the rocks are "full of fissures," some of them might be large enough to allow of the passage of eels or fish. So it is not very easy to answer the question.

But I would say, in a general way, that almost anything which takes water from the ground, except driven wells, is accounted a filter-gallery. Really it may not be true, because many of these galleries are intercepting galleries. For instance, there are many cases of subterraneous water-supply finding its way down a valley into a pond. In these cases, where the material is loose, coarse gravel, you can often successfully build a gallery across a subterraneous stream, and thus intercept water on its way to a pond. But a filter-gallery, strictly speaking, would be parallel to the shore of the pond, to filter water coming from the pond through to the gallery. Of course, if the material is fine enough to be of any benefit at all as a filter, it obstructs the water, and if it takes anything from the water, it leaves it in the filter. Now, after water has passed through a filter a certain length of time, if it is water that badly needs filtering, it most certainly blocks the filter; and if the water succeeds in getting through at all, it must get through by the decay of the material in the filter. Therefore, as a general rule, I would say that a filter-gallery is only one of things which should be resorted to in case of dire necessity.

I don't believe in subterranean supplies, where it can possibly be helped. They are resorted to oftentimes where nothing else can be done — where no other water can be obtained. We are oftentimes called upon to furnish a water-supply to a town where there is no water, and it looks for a time as though you have got to make it. I would say, at this point, that I doubt whether these filter-galleries have any effect, materially, on the purifying of the water, except in extreme cases, where matter is held in suspense. They may change the color of the water in some respects; but, as Mr. Stearns has said, the color does not necessarily affect the water from the health point of view. I have seen the water-supplies in some of the Western towns — and I have in mind at present a town which I visited within a year, in Nebraska — where a supply was taken from half a dozen driven wells. In this case there was a valley. The town, which contained about five thousand inhabitants, was built directly in the valley, and there was a river which flowed through it. The water in the river was itself of a greenish color and very rily. I don't suppose you could see two inches into it, and it looked very bad indeed; but these wells were driven within four hundred feet of the river, and some of them had been driven in the lower part of the town, where stables and everything of that kind had collected, and the offal had been dumped around the wells. In the West, you know, they don't use offal for fertilizing purposes, but it is dumped around to fill up with. In addition to these wells, to make sure of a good supply of water, they had carried a pipe directly into the river three or four hundred feet distant. On the bank of the river, at the entrance of this pipe, there was a large hog-pen, with forty or fifty hogs in it, and when I was there I saw within twenty feet a dead dog. The people were drinking this water; and a man could drink a pailful of it and it didn't hurt him at all. I would say

that the people of the place were as hale and hearty looking as any I ever saw. I made some inquiries in relation to the condition of their health, and found that their health bills were as good as those of the same number of people in any community I was ever in, and I have sometimes wondered if that sewerage wasn't intended for food. (Laughter.) It certainly didn't hurt me and didn't hurt anybody else there, and I have sometimes thought that the water had more body to it than the water here. (Laughter.)

At any rate, I think the dangers from pollution of water are greatly overdrawn, and I don't believe they are as great as they are often said to be. The water in this town was wet, and if furnished in sufficient quantities would answer all purposes as far as putting out a fire was concerned — in fact, it answered every requirement. (Laughter.)

But I have diverted from the great question at issue. The question is whether a filter-gallery would be practicable in the case referred to? I should say it might be practicable to build it under such circumstances, but the gallery would be worthless, and I would take the water from the pond every time. In regard to the cost of such a filter-gallery, it would depend wholly upon circumstances. It might be anything from five hundred dollars to a million dollars, and under some circumstances you could not construct it at any price. The question is one that is too difficult for me, and I don't think I am able to answer it, in that respect, at all. (Applause.)

The President stated that he had received a letter from ex-President Gardner, of the American Water Works Association, at present Superintendent of the New Orleans Water Company, and a paper from William E. Davis, Superintendent at Sherburn, N Y., both of which would be read at the next meeting.

Messrs. Monroe and Pratt sang a duet, "Vieni Meco."

Adjourned, on motion of Mr. Brackett, to meet on Wednesday, Feb. 11, 1891, at Young's Hotel.

QUARTERLY MEETING.

YOUNG'S HOTEL, BOSTON, Feb. 11, 1891.

The Association was called to order at 2.30 o'clock, P.M.

Register of Attendants.

ACTIVE MEMBERS.

Solon M. Allis, Malden, Mass.
Henry W. Ayres, Hartford, Conn.
Geo. E. Batchelder, Worcester, Mass.
Phineas Ball, Worcester, Mass.
Chas. H. Baldwin, Boston, Mass.
Joseph E. Beals, Middleboro', Mass.
Wm. R. Billings, Taunton, Mass.
Dexter Brackett, Boston, Mass.
John G. Brady, Worcester, Mass.
E. J. Chadbourne, Holbrook, Mass.
Geo. F. Chase, Taunton, Mass.
Ezra Clark, Hartford, Conn.
R. C. P. Coggeshall, New Bedford, Mass.
Elmer E. Farnham, Sharon, Mass.
F. F. Forbes, Brookline, Mass.
Frank L. Fuller, Boston, Mass.
Albert S. Glover, Boston, Mass.
W. J. Goldthwait, Marblehead, Mass.
J. A. Gould, Jr., Boston, Mass.
E. H. Gowing, Boston, Mass.
Frank E. Hall, Quincy, Mass.
John Harris, Waltham, Mass.
Geo. W. Harrington, Wakefield, Mass.
John C. Haskell, Lynn, Mass.
Wm. Hawes, Fall River, Mass.
Horace G. Holden, Nashua, N.H.
J. C. How, Jr., Haverhill, Mass.
Geo. A. Kimball, Boston, Mass.
A. E. Martin, So. Framingham, Mass.
Josiah S. Maxey, Gardiner, Me.
Chas. W. Morse, Haverhill, Mass.
Hiram Nevons, Cambridge, Mass.
Albert F. Noyes, West Newton, Mass.
John D. Shippee, Holliston, Mass.
Geo. A. Stacy, Marlborough, Mass.

M. M. Tidd, Boston, Mass.
C. H. Truesdell, No. Grosvenordale, Conn.
Geo. E. Winslow, Waltham, Mass.
E. T. Wiswall, West Newton, Mass.
Millard F. Wright, Lowell, Mass.

HONORARY MEMBERS.

E. R. Jones, Boston, Mass.

GUESTS.

Mayor Harrington, Worcester, Mass.
Representative Taft, Worcester, Mass.
Representative Wheaton, Worcester, Mass.
President Wheeler, Cambridge City Council.
E. A. Stevens, Malden, Mass.
W. L. Faxon, Quincy, Mass.
H. L. Lincoln, Cambridge, Mass.
H. E. Bullard, Holliston, Mass.
J. T. Murphy, Marlborough, Mass.
G. E. Smiddy, No. Grosvenordale, Conn.
J. H. Flint, Chairman of Committee, Andover, Mass.

ASSOCIATES AND REPRESENTATIVES.

Jas. M. Betton, Boston, Mass.
John L. Millar (Chas. Millar & Son), Utica, N.Y.
Chas. H. Eglee, Flushing, N.Y.
J. A. Mitsch (W. H. Gallison), Boston, Mass.
Mr. Gilchrist (Gilchrist & Taylor), Boston, Mass.
H. A. Tilden (Hersey Mfg. Co.), Boston, Mass.
Henry F. Jenks, Pawtucket, R.I.
Mr. Stevens (Peet Valve Co.), Boston, Mass.
H. G. Bond (Perrin, Seamans & Co.), Boston, Mass.
H. P. Hutchinson (Standard Thermometer Co.), Peabody, Mass.
Geo. F. Low (Standard Thermometer Co.), Peabody, Mass.
G. H. Carr (Union Water Meter Co.), Worcester, Mass.
Mr. Rice (Walworth Mfg. Co.), Boston, Mass.
Wm. S. White, Boston, Mass.
Wm. Wolfendale, Fall River, Mass.
Jesse Garrett (R. D. Wood & Co.), Philadelphia, Pa.
H. A. Gorham (Geo. Woodman & Co.), Boston, Mass.
A. A. Blossom (Whittier Machine Co.), Boston, Mass.

The PRESIDENT. — It is with some feeling of regret that I am compelled to call the members to order at this time, for I know you are all having a pleasant time chatting together at the tables. During this month our friend, Mr. Pratt, of Cambridge, has been learning various things, and among other things I understand he has been learning all about Schneider. Now, in order to hear

from him, it will be necessary for you to keep very still, as he has quite a low voice (laughter), and on that condition Mr. Pratt has agreed to tell about it. The Association having agreed to comply with your request to keep perfectly still, we will now hear from you, Mr. Pratt. (Applause and laughter.)

Mr. Pratt then sang "Schneider's Band," after which the President called upon the Secretary to read applications for membership, which he had received from the following persons: —

For resident active membership: Abbott A. Jenkins, Superintendent, Milford Mass.; Joseph W. Swan, Assistant Clerk Boston Water Board, Boston, Mass.

For non-resident active membership: Murray Forbes, Superintendent Westmoreland Water Co., Greensburg, Penn.

For associate membership: Charles Millar & Son, cast iron, Utica, N.Y.

On motion of Mr. Hawes, the Secretary was directed to cast the ballot of the Association for the gentlemen whose names had been read, which he did, and they were declared elected members.

The PRESIDENT. — We have with us to-day, as guests of the Association, men whom we feel proud to have associated with us, and some of them have kindly consented to speak to us. It gives me great pleasure to introduce to you President Wheeler, of the Cambridge Common Council.

Mr. WHEELER. — Mr. President and gentlemen of the Association, my connection with water-works has been very limited, but up to this time, however, it has been very pleasant. Now I appear to have struck a snag which I don't know just how to get around. I have had great pleasure in being here with you to-day, as I did when I met you about three years ago in Cambridge. If I were to tell you all I know about water-works, it would take but a very little time. I know the city of Cambridge has got as good water-works as any city in Massachusetts, or perhaps as any city in the United States of its size. I also know we have a superintendent whom we all feel proud of, and I think from what I know of this Association that you feel proud of him. That is about all I know about water-works, and so I think I had better retire in favor of somebody who can tell you more.

The PRESIDENT. — I see a gentleman over in the corner of the room (I regret I have not had an opportunity to speak with him) whom we shall all be glad to hear from, and I will call upon Dr. Faxon, of Quincy. (Applause.)

Dr. FAXON. — When my friend Mr. Hall said to me yesterday, "I hope, Doctor, you will be able to come in to the dinner of the Association to-morrow," I did not expect to be called upon to say anything in favor of cold water. I have attended two dinners of this Association, and at both of them we have had water, which has been very sparingly partaken of by the members. They have tasted it apparently to see if it was any foreign substance that they weren't acquainted with, and finding it was an old acquaintance they have endorsed it, said it was very good, and then passed on to try the next. (Laughter.) I remember the dinner at which the Association entertained the United States Association, and on that occasion Governor Robinson stated, as I recall it, that he was very certain that so long as the members of the New England Water Works Association continued to practise as he observed them, there would never be any scarcity of water in Massachusetts, for he had seen them upon a great many occasions, and had noticed they never drank any. (Laughter.)

Now, I have had a little something to do with cold water. My distinguished relative, Henry H. Faxon, says his specialty is more with rum than with water. (Laughter.) He says that he can get water almost anywhere, but to get hold of a little rum, and poor rum at that, is a very difficult matter. He says he has been looking after it for a great many years, although as far as he personally is concerned he don't want a great deal of it.

But aside from anything in the shape of fun that there may be in these gatherings of the Association, there is a good deal that an organization like this, and that water companies and towns and cities that have Water Works, can well do in giving people an idea about water that they have never had before. The people of New England have lived here a great many years on a barren soil, and have worked hard to get hold of a dollar about all their lives, and are scratching for it possibly about as hard now as they were two hundred years ago. Water is still in a great many places looked upon, not as a necessity, but as a luxury; and the more advanced idea in many other places is that water is merely something that must be had to keep away disease, as wells become impure from local drainage, and that it possesses nothing except utility; that it has no ornamental possibilities; that it contains nothing but qualities that make it fit for man and beast to drink, and as something to cook with and to wash in. I said a few years ago out in Cambridge, when they were having a little difficulty there about getting pure water, or pure beer, or pure liquor of any description to drink, on account of the no-license action of the local authorities, that one great purpose that was not subserved by water-supply companies was giving it, as it ought to be given, to people outside of their houses.

In speaking with a gentleman who sits here by me, a few moments ago, I used the expression "to cool one's coppers." (Laughter.) Possibly the majority of the members of the Association don't know just what that term means. But there are a few men here who have lived pretty well into the third quarter of their century of life, and they know that there used to be a time in the old days in Massachusetts when it was possible to get three drinks of good New England rum for three cents. (Laughter.) They used to have headaches in the morning; they would dance with the girls till two or three o'clock, and then get up at five o'clock and go to work; and their heads ached, and their coppers were hot, and they couldn't cool them with liquor, so they had to have water. Now, there are a good many people in communities where they have a public water-supply who would like oftentimes to cool their coppers (laughter), and it is pretty hard for them to do it, especially in the summer. And I hold it is the function of cities and towns having water-supplies to furnish the water in such condition, and in such ways, and so conveniently to their inhabitants, that every man who wants to cool his coppers can do it. (Laughter.) Instead of being obliged to step into an unlicensed saloon and put his hand up to his mouth and whisper, "Gin-sling," he wants to be able to walk up to a fountain every two blocks in the street, and find a place where there will be a little stream of water running out of a little hole where there will be a little ice, and there he can cool his coppers, and not be obliged to go into a place to get some cool beer to cool them with. In the summer time, you know, they sell cool beer, not warm beer: the saloon keepers understand their business.

Now, the Water Works Association can do a good deal in the way of en-

couraging the use of water as a beverage, for I believe it has been officially decided by the Commonwealth of Massachusetts that water is a beverage, by putting it before the people in such a way that it will be palatable and convenient for many people who have not been used to water as a beverage, and who don't know anything about it for that purpose, and who are only accustomed to think of it as something to swim in, and once in a while to bathe in. We could do a great deal toward cutting off the sale of liquors which will not cool the coppers, and will not cool the heads, either. We could make water fashionable, we could make it palatable, we could make it popular. Then there is another thing we could do with water. We could have it so bountifully supplied that we could go with it into the meanest and lowest corners of these thickly settled cities, and clear up a little place and put a fountain there, and by the aid of the water that would run there we could make what was a slum a place of beauty; we could make it something that the people around there would take pride in. We should not begin, I believe, so much by putting these fountains on the parks — places which the city is bound to improve and beautify. I should not so much favor investing our money in putting up a fountain in some place where the people are rich, and where the natural attractions are sufficient to make it a beautiful spot. But we should go to the meanest place in the town and give it the attraction water can be made to bring to it, and in such a way that it will do something towards lifting those people up and giving them an idea of beauty. Cities are the largest users of water; they have the largest interest in elevating the people; and I think the influence of this Association could be made to work in such a way that cities would expend money for beautifying, through the influences of water, the localities where dwell those people who now feel, many of them, that all they exist for is simply to earn wages and live from day to day in order that somebody else may get the benefit of their toil. I think that is a thing that this Association, as a whole, might go into; and that an expression from this Association, through a committee which might present some definite plan, — not detail plans for working, but an idea that could be carried out, and some definite spot to begin at, for there must unquestionably be some place where the work can be begun — would be of almost untold value. It is a thing which has not yet been attempted, but it is something I would like to see undertaken.

Now, to show what can be done, I will say that in Quincy a little society was started for village improvement, and within a few years the members — there are not more than eight or ten active members — have set out a great many trees, and we have now in hand a fund of a little more than $6,000, with which we propose to put up this spring, the contract being already let, a drinking-fountain. There will be two basins for horses, each about seventeen feet in circumference; and the top of it will be a basin some six or eight feet across, to be reached by a flight of steps, which is round, to take up the other third of the circle, and that is to be for water to run in, and where facilities will be afforded for pedestrians to drink. I don't know but it will be said this is in the interest of the Quincy Water Company, because we want to sell the water, and possibly the town may not vote to put it in for that reason; but the Village Improvement Society will furnish the fountain, and we have no doubt that some way will be found to furnish it with water. This will be the first bit of public work for purely orna-

mental purposes that has ever been erected in the town. We have a few horse-troughs there, but this fountain will be a thing of beauty as well as of utility, and the great charm of it will be simply because there will be a stream of water flowing over the top and running down perpetually. It is going to stand almost directly in front of the house of the great apostle of temperance, who, by the way, hasn't given a dollar towards it. (Laughter.) We are going to remind him all the time of the advantages of water. He can go over there and drink his fill and cool his coppers whenever he wants to. I think it is the intention of the society there to create a fund, and whatever fund they do create is to be used for the erection of fountains, which shall be ornamental as well as useful, believing that it will be the beginning of an education in the way of a public spirit such as the town has never yet had. And I believe if similar societies could be started elsewhere, or, as I said some time ago, if this Association would start an organized effort, it would be the means of doing a great deal, and it would abolish any amount of filth and slime that there is now in our cities, and would be the means of starting a new life out of which would spring up a better set of boys and girls, — boys and girls who would be kept free from many of the vicious influences which otherwise would drag them down, and that a great many who are now under those influences could be brought to something better. (Applause.)

The PRESIDENT. — In considering the programme for this meeting, and what could be done that would yield the greatest interest and value to the members of the Association, it was felt that it would be wise to devote this meeting almost entirely to experiences of members during the past year. Most, if not all of us, have had some work of a peculiar nature to do, in doing which we have had to use special means, and from which we are looking for some special results. Quite a number of papers have been sent in, and before calling upon gentlemen who are present, I think perhaps it would be well to have some of these papers read. At the last meeting there was a paper received from Mr. Davis, Superintendent of the Sherburne Water Works, New York, which was incomplete in certain details of information, which have since been supplied. Mr. Holden, of Nashua, who has taken an interest in the paper, will very kindly read the communications from Mr. Davis.

Mr. Holden then read Mr. Davis' paper, which was entitled "Experience in Moving Main Pipe."

The PRESIDENT. — One of the letters sent out to our members found, amidst the cares of his position, our friend, Mr. Gardner, Superintendent of the New Orleans Water Company. Notwithstanding all his trials and tribulations he has kindly found time to write a very interesting paper for us, entitled "The Soft Answer," which the Secretary will read.

Secretary Coggeshall then read Mr. Gardner's paper, and after a song by Messrs. Pratt and Monroe, Mr. George F. Chace, Superintendent of the Taunton Water Works, read a paper entitled, "The Care of Water-Mains in Relation to the Quality of the Supply."

Mr. Chace was followed by Mr. E. H. Gowing, C.E., who read a paper entitled "An Experience in Crossing a Stream with Main Pipe."

The PRESIDENT. — During the past season probably but few of our members have had so large an experience in the study of the effect of water upon various

materials as our friend Mr. Forbes, of Brookline, and he has something to say to us on the proper materials for well construction.

Mr. Forbes then read a paper entitled "Driven Wells as a Source of Water-Supply," after which the Association adjourned, to meet Wednesday, March 11, 1891.

THE EFFECT OF STORAGE UPON THE QUALITY OF WATER.

BY

F. P. Stearns, Engineer Mass. State Board of Health.

There are very few water works in the State which obtain a supply from the ground or a running stream, and convey it directly to the consumer. All others depend to a greater or less extent upon storage; it may be at the source of supply, as when water is taken from a pond or reservoir, or it may be the lesser storage in distributing reservoirs or iron tanks designed to hold a sufficient supply for fire purposes and other emergencies. Storage by any of these methods may be expected to effect some change in the character of a water, and in many instances it is known to be the cause of much trouble from bad tastes and odors. As storage is an essential feature of most water works, so that we cannot obviate the troubles by doing away with it, the problem before us is to provide it under such conditions that there will be the least danger of the occurrence of these troubles. In treating this subject, I will take up the different classes of storage separately.

Surface Waters Stored in Open Distributing Reservoirs.

That there may be no misunderstanding, I will say that I mean by open distributing reservoirs only those which are partly excavated in the ground, and are lined with earth, stone, or masonry; and I do not include the Chestnut Hill and Brookline reservoirs of the Boston Water Works. All iron structures are classed as tanks.

Analyses have been made by the State Board of Health of samples of water taken simultaneously from ponds and storage reservoirs and from the corresponding distributing reservoirs.

The reservoirs first selected for comparison are at Marlborough, Gardner, Danvers, Salem, Norwood, and Boston; the comparison at the last place being between the waters of the Chestnut Hill and Fisher Hill reservoirs.

The average analyses of the water before and after being pumped and held in the open distributing reservoirs are as follows: —

[*Parts per 100,000.*]

	Water before being pumped.	Water in open distributing reservoirs.
Color	0.20	0.20
Total residue on evaporation	3.94	3.95
Free ammonia	0.0023	0.0019
Albuminoid ammonia	0.0178	0.0187
Nitrogen as nitrates	0.0077	0.0077
Nitrogen as nitrites	0.0001	0.0001
Chlorine	0.41	0.42

These comparisons show that there was no change of any practical importance due to the pumping and storage in the open distributing reservoirs, as far as could be ascertained by chemical analysis; and this being the case, it is quite certain that there was no appreciable change in the appearance or quality of the water.

The next comparisons were similarly made with the four reservoirs at Lawrence, Lowell, New Bedford, and Worcester. At each of these places the water entering the distributing reservoir is aerated by falling over a weir, or down stone steps, or from the top of a pipe projecting above the surface of the water; and, in addition, at Lowell and Lawrence the supply from the Merrimack River is supplemented to a very slight extent with water from filter-galleries, so that the water stored is not wholly surface water. The first samples in these two cases were taken beyond the point where the mixing of the water from the two sources took place.

The results obtained at Lowell, New Bedford, and Worcester are the same as those obtained with the seven reservoirs, first compared, where there was no aeration; that is to say, in these three cases there was no change due either to aeration or storage.

At Lawrence there is a very noticeable purification of the water in the reservoir, which continues as it passes through the pipes to the consumer. If we measure this by the reduction of the albuminoid ammonia which represents the organic form of nitrogen, and the corresponding increase of nitrates which represent the inorganic form, we find that the former reduces from .0174 parts per 100,000 at the source to .0144 as the water leaves the reservoir, and still further to .0117, when it reaches the further end of the distributing system. The total reduction is consequently 33 per cent. The corresponding increase in nitrates is from .0135 to .0192, equal to 42 per cent. The reason for the improvement of water in this reservoir and not in the others is not entirely clear, but it seems probable that it is due to the character of the river water which only nine miles above Lawrence receives the sewage of Lowell. It is also worthy of notice that the reservoir at this place is unusually large, which would give an unusual amount of time for any change which such water might undergo on standing.

The only other comparison made was between Mystic Lake and the College Hill reservoir of the Mystic supply. Here there appeared to be an improvement somewhat similar to that at Lawrence; but the results in this case are not as trustworthy, on account of the great changes which take place in the character of this water from month to month.

From these examinations the conclusion can be reached that surface waters will not deteriorate when stored in open distributing reservoirs, but that the change due to such storage, if any, will be beneficial.

There are no instances in the state of surface waters stored in covered reservoirs; but it seems probable that under such conditions water containing many algæ might become worse, owing to their death when deprived of light.

Ground Waters Stored in Open Distributing Reservoirs.

This is a subject which has been brought before you so many times, that nearly all I can say upon it must have a familiar sound, and I will therefore treat it briefly.

In order to show more clearly than I otherwise can the relation of a chemical analysis to the changes in character which are perceptible to the senses, I will refer to a portion of the Hyde Park experiment, which has already been called to your attention at a previous meeting by Professor Drown. The portion to which I refer is the filling of the open reservoir with water fresh from the wells, after it had twice been emptied and thoroughly cleaned; and the subsequent storage, for more than a month, of the water then pumped in. The filling of the reservoir began May 16, 1889, and was completed in six days.

Samples of water from the reservoir were collected from time to time (beginning two days after the filling of the reservoir was completed) and analyzed. The character of the water pumped from the ground into the reservoir was also known from analyses made a short time before.

The salient features of the experiment can be indicated by the partial analyses of four samples, the first representing the water with which the reservoir was filled, and the others being taken respectively two days, one week, and one month after the filling of the reservoir.

Analyses of Water from the Hyde Park Open Distributing Reservoir.

Date.	Albuminoid Ammonia.		Nitrogen as Nitrates.
	Dissolved.	Suspended.	
Water entering reservoir May 16 to 22, 1889	.0016	.0000	.0600
May 24, 1889	.0054	.0170	.0450
May 29, 1889	.0082	.0406	.0040
June 26, 1889	.0128	.0060	.0030

In interpreting these analyses it will not be far out of the way if we consider the nitrates as representing food; the suspended albuminoid ammonia, the algæ and other organisms, and the dissolved albuminoid ammonia, an extract of dead organisms, with perhaps, in addition, the excreta of live ones. With the above definition, the history of this water may be stated as follows: —

The algæ began to grow as soon as water was turned into the reservoir, and thirteen days after beginning to fill it had appropriated nearly all of the large amount of food which the water originally contained. They then began to die of starvation and fall to the bottom, where they still continued to affect the water by contributing to it some dissolved organic matter. This experiment indicates very clearly the nature of the changes in the chemical analysis of a ground water which takes place when it deteriorates from being stored in an open reservoir; and in a comparison of different cases, the amount of these

changes is to some extent a measure of the amount of deterioration which takes place, as observed by those who use the water.

Before leaving the Hyde Park case, it is well to say that it illustrates one of the spurts in the growth of algæ when supplied with fresh water containing an abundance of food, which have been so well described to you by Mr. F. F. Forbes,[1] and consequently represents in an exaggerated way the changes which take place in reservoirs as ordinarily used, in which case only a small part of the water is replaced at any one time.

There are in Massachusetts thirteen instances in which ground waters are stored in open distributing reservoirs. In seven of these in which the water is pumped directly from dark ground water sources to the reservoir, there is a sufficiently large number of analyses from which to draw trustworthy conclusions. These are Hyde Park, Brookline, Cohasset, Ware, Woburn, Revere, and Kingston. The following table contains the changes in albuminoid ammonia and nitrates in each of these waters.

Table showing Change in Amount of Albuminoid Ammonia and Nitrates in Ground Water, due to Storage in Open Distributing Reservoirs.

Town.	Albuminoid Ammonia.			Nitrogen as Nitrates.
	Total.	Dissolved.	Suspended.	
Hyde Park	+.0170	+.0041	+.0129	—.0344
Brookline	+.0130	+.0053	+.0077	—.0191
Cohasset	+.0090	+.0041	+.0049	—.0227
Ware	+.0083	+.0052	+.0031	—.0336
Woburn	+.0059	+.0026	+.0033	—.0094
Revere	+.0050	+.0024	+.0026	—.0209
Kingston	+.0038	.....	.....	—.0115

Note. + indicates increase. — indicates decrease.

As Hyde Park is shown here to have the supply which is most affected, it is only fair to state that the condition above indicated will not exist in the future, as a covered iron tank from which all light is excluded has been built and will take the place of the open reservoir.

The amount of trouble which is caused by the different reservoirs, as indicated by practical experience, may not accord in all cases with the chemical change; still I believe Hyde Park and Brookline are properly at the head of the list, and that Revere and Kingston should be near the foot, showing that the chemical analysis is generally a fair index of the amount of trouble.

[1] Journal of the New England Water Works Association, June, 1890.

The six cases not in the table include those in which the water at the source is collected in an open basin, so that it is to some extent affected by the light before being pumped, also those of which but few analyses have been made. Enough is known about all of them to warrant the statement that the water in the reservoirs has deteriorated in about the same way as in the seven cases tabulated.

Storage in Iron Tanks.

The storage of water in iron tanks, either covered or open, has not generally caused it to deteriorate to any considerable extent, even if taken from the ground. There is, however, a notable exception to this rule in the case of the Brookline high-service tank, which before being covered gave as much trouble as the open distributing reservoir. It is best, therefore, to follow the same rule with tanks as with reservoirs, and cover all which are to hold ground water.

Storage of Surface Waters in Large Artificial Storage Reservoirs or Ponds.

The causes of occasional bad tastes and odors in large bodies of stored water can, in most cases, be properly attributed to the presence of algæ or other minute organisms; but when in the past we have attempted to go further, and try and ascertain the causes which led to the growth of these organisms, the results have been most unsatisfactory. To quote a remark made several years ago by one of our able water-works engineers, he said: "I don't know what causes these troubles, but I think I know enough about it to demolish any theory which any one can bring forward."

I have classified the ponds and reservoirs of the State, both with reference to the occurrence of tastes and odors, and to the conditions which appeared to be most likely to produce them, and think I have found some of the primary causes of these troubles. In making a classification of this kind, where the number of sources to be classified is not very great, it is obviously necessary not to make the classification too minute; therefore many sources have to be grouped, which in some respects are quite different. The basis adopted is as follows: Ponds are separated from reservoirs, all natural ponds being classed as such even if they have been made artificial in part by being raised. Ponds and reservoirs are classed as polluted when the population on the drainage area is more than 300 to the square mile, and the waste products from this population enter them either directly, or indirectly by filtration through the ground. When the average depth is less than 9 feet, the pond or reservoir is called shallow; and in two instances where there is a great deal of very shallow flowage, ponds having an average depth of 10 feet are called shallow. Water having a color of 0.3 or more is assumed to have a high color.[1] All sources which have at any time given serious trouble from bad tastes and odors are classed as giving trouble, and a further distinction is made between those which have given much and little trouble by including in the latter class all of those in which the aggregate duration of the trouble has not exceeded one month in five years.

Before entering upon details I will present the aggregate results: —

There are in the State 71 ponds and storage reservoirs which have been care-

[1] The color of waters is expressed by numbers, which increase with the color. The water which has the highest color of any used for water-supply purposes averages about 1.40. Water drawn from a tap in Boston is generally about 0.35.

fully examined, nearly all of which are used for water-supply purposes. Of these, 45 or 63 per cent. have at some time given trouble from bad tastes and odors. In some, however, the trouble has been of slight extent, or has occurred only after long intervals; and if these are omitted we have left 29, or 41 per cent. of the total number, which have given much trouble.

In preparing the classification which follows, it seemed desirable to omit five ponds and reservoirs, because they could not be properly classified. Three of these are recently-filled reservoirs, and the trouble which they now give may not continue when they are older. The other two are Farm Pond and Chestnut Hill reservoir (both of which have once been seriously affected), which are omitted, for the reason that the pond derives most of its supply from artificial reservoirs and not from its own watershed, and the reservoir at the time of the trouble received water only from Lake Cochituate.

A Classification of Ponds and Reservoirs with Reference to Troubles from Bad Tastes and Odors.

Condition.	Ponds.			Reservoirs.		
	Much Trouble.	Little Trouble.	No Trouble.	Much Trouble.	Little Trouble.	No Trouble.
Polluted.						
Shallow and high color	.....	.....	.....	1	.....	.....
Shallow and low color	.....	.....	.....	.....	.....	.....
Deep and high color	1	.....	.....	.....	1	.....
Deep and low color	3	4	.....	.....	.....	.....
Total polluted	4	4	.....	1	1	.....
Unpolluted.						
Shallow and high color	.....	.....	1	10	.....	.....
Shallow and low color	3	1	.....	1	.....	2
Deep and high color	.....	2	2	1	2	4
Deep and low color	1	4	16	3	2	1
Total unpolluted	4	7	19	15	4	7
Total polluted and unpolluted	8	11	19	16	5	7

In the table on p. 120 there are 38 ponds, of which 8, or 21 per cent., have given trouble, and 28 reservoirs, of which 16, or 57 per cent., are similarly affected.

The effect of pollution can best be seen by comparing the polluted and unpolluted deep ponds. Of the former there are eight, all of which give trouble, and half of them much trouble. Of the latter there are 25, of which only one gives much trouble, and six a little trouble; leaving 18, or 72 per cent., of the whole which have never been affected.

These results are deduced from the experience with so many ponds, and the conditions of the two groups are so nearly alike in every respect except pollution, that I consider them as showing definitely its effect. Only two of the reservoirs are polluted so that the information obtained from them is not conclusive. So far as it goes, however, it is in line with that furnished by the polluted ponds, one of the reservoirs giving much trouble, and the other a little.

The shallow unpolluted ponds are more affected than the deep ones, three giving much trouble, one a little, and one none. In this case the table may give a somewhat more unfavorable indication than would be found in shallow unpolluted ponds in general, as one of the ponds which gives much trouble receives some sewage, though not enough to bring it in the polluted class, and at the same time has a large amount of very shallow flowage; and another is a small pond near the sea, and obtains much of its supply from the ground.

The unpolluted reservoirs remain to claim our attention. Of these there are 26 in all, one-half shallow and the other half deep. Eleven of the shallow ones give much trouble and two give none. In nearly all of these cases in which trouble has occurred the reservoirs have been constructed on new sites and the vegetable matter has not been removed from their bottom and sides. In one of the cases where there is no trouble the reservoir was previously used for mill purposes.

Of the thirteen deep unpolluted reservoirs, four give much trouble, the same number little, and five none. It is noticeable in this comparison that of these five, four have had the soil and vegetable matter removed, and the other was originally a mill reservoir; while of the eight which have given trouble, none have been thoroughly cleaned, and only one was a mill reservoir, and this has been raised. Two of the older reservoirs which are classed as giving little trouble have not given any in recent years.

I have not mentioned the effect of the color of the water, and will only say that its effect, if any, is very much less than that of pollution and the conditions of storage.

The facts presented in the table, as I have already indicated, point clearly to trouble from two causes: —

First, population on the watershed.

Second, vegetable matter in the bottom of reservoir, particularly when the reservoir is shallow. These causes appear quite unlike, yet they are similar in this respect, that both contribute to the water nitrogen, which is an important part of the food of algæ. A moderate amount of nitrogen derived from the rainfall and washed from the ground is always found in any water-supply, and is sufficient to maintain a limited growth of algæ; but it appears that an excessive growth occurs only in waters which receive additional nitrogen from artificial sources.

As a result of this study the following conclusions may be drawn, bearing in mind all the time that the subject is being considered from the standpoint of tastes and odors, and not of public health.

First. A source should not be selected which has a large population on the watershed. The classification shows that every pond or reservoir having upon its watershed a population exceeding three hundred per square mile has given more or less trouble, and it is probable that a much smaller number may have an injurious effect.

Second. A pond is preferable to a reservoir unless the latter has had all soil and vegetable matter removed from it, in which case there appears to be but little choice. In the case of very old reservoirs, such as those which have been used for mill purposes for a great many years, the conditions closely resemble those which exist in ponds.

Third. Where it is necessary to build storage reservoirs on new sites, all soil and vegetable matter should be removed, particularly where the reservoirs are shallow. I am well aware that the expense of such preparation may, in some instances, be prohibitory, in which case it is well to consider what conditions will be least likely to cause trouble in an uncleaned reservoir. Experience indicates that depth is an important feature, and that very shallow flowage, which will permit aquatic plants to grow from the bottom and subsequently decay in the water, is particularly to be avoided. A large flow, in proportion to the size of the reservoir, is desirable, as the frequent renewal of the water will prevent the accumulation in it of nitrogen derived from the uncleaned bottom.

The Effect of Storage upon the Color of Water.

In all of the above statements regarding the storage of water, no reference has been made to its effect upon the color. It has frequently been asserted in water-works reports that storage would remove the color, and certain instances have been mentioned in which this effect was produced. In other instances the color has seemed to be persistent, which has occasioned the thought that the bleaching effect of storage was very much overestimated. The work of the State Board of Health enables me to give you some facts with regard to this: —

Observations have been made of the color of the water in the principal stream feeding each of several reservoirs and ponds, and of the water at their outlets. All of these bodies of water are also fed, to a limited extent, from the territory about them both from surface and subterranean sources, and this water is, as a rule, lighter colored than that in the main feeder, thereby reducing the color of the water in the reservoir by dilution.

In presenting the results, in a table which follows, the observed colors at the main inlet and the outlet, each representing the average of a long series of examinations, are given, also an estimated average color of all water entering the reservoir. This is obtained by correcting the color of the water at the main inlet to allow for the dilution caused by that entering from the other sources. This correction is necessarily only approximate, but it is better than none, and is so small that whatever error may exist will not materially affect the results.

Table showing the Effect of Long Storage upon the Color of Water.

Locality.	Percentage of watershed above inlet.	Average time required to fill reservoir; months.	Color at main inlet.	Estimated average color of all water entering reservoir.	Color at outlet.	Change.
Boston W. W., Reservoir 3.....	.79	1.3	1.00	0.86	0.82	—.04
Boston W. W., Reservoir 2.....	.97	0.4	1.10	1.07	0.98	—.09
Boston W. W., Lake Cochituate.....	.40	8.5	0.86	0.58	0.25	—.33
Boston W. W., Reservoir 4.....	.84	7.5	1.40	1.27	0.72	—.55
Brockton Reservoir...	.82	3.4	2.24	1.87	0.89	—.98

The table shows a very small decrease of color in Reservoirs 2 and 3 of the Boston Water Works, in which the water remains on an average only about a month, and a large decrease in the other bodies of water, in which the water remains on an average from 3.4 to 8.5 months.

Two excellent opportunies to determine the effect of storage upon color were afforded when the Parker Hill distributing reservoir of the Boston Water Works was temporarily shut off from the rest of the system and no water passed into or out of it. It was first shut off Dec. 3, 1887, when the water in it had a color of 0.4. On April 2, 1888, the color was 0.35, or only a little lower than four months before; but on the 18th of June, 1888, the color had reduced to 0.1. The reservoir was next shut off Jan. 9, 1889. No direct observation of the color of this water was made at this time; but from examinations of the source from which it is supplied, its color is known to have been 0.45. On June 4 of the same year the color had reduced to 0.05, and two months later the water was colorless.

From the foregoing observations, and some others which I will not take the time to relate, the general conclusions may be reached that the color of water is reduced by exposure to light and air in a storage reservoir; but that it must be stored for several months to cause any material reduction, and from six months to a year to remove practically all of the color.

DISCUSSION.

The President. — We all feel that the work of the State Board of Health in making these investigations will redound to the great benefit of the profession at large. The city of Boston, through its resident engineer and superintendent, had also been engaged in making an investigation in connection with this matter, so

far as it relates to the Boston water-supply, and Mr. FitzGerald has very kindly consented to supplement Mr. Stearns' remarks by a paper giving the results of his investigation. I will introduce to the Association Mr. FitzGerald. (Applause.)

Mr. FitzGerald said: Mr. President and fellow-members, it is true that I consented to bring a paper here to read to you, but I think, on the whole, I will not inflict it on you at this late hour, especially as it is possible to give you the gist of the matter in a few words, and as Mr. Stearns has so nicely laid before you, in actual figures, many of the results to which I may refer.

In the early part of last year I made a somewhat careful examination, for the Boston Water Board, of several matters pertaining to the sanitary condition of our water, and among them I went somewhat into a study of the effects of storage upon our water. Our many basins, ponds, and lakes afford good opportunities for studying these results.

I think we hardly appreciate the strides that have been made in the last twenty years in this whole matter of the examination of water with reference to its quality; but it will be sufficient to impress it upon your minds if I tell you that when the Sudbury water was first introduced into Boston, two analyses were considered sufficient to form a basis for a judgment of the quality of the supply, and those two analyses were by no means what we should now call complete. They gave only residues, not the nitrogenous matter. Now, we owe a great debt to the work of the State Board of Health, and to the admirable work that Dr. Drown has done. It seems to me that he has carried the analysis of water far beyond anything we had before, and has done it so accurately and nicely that we are able to judge, as engineers, of a great many things that were previously unknown.

The water that supplies basin 2 is of an entirely different character from that which comes into basin 3, and after a careful study for a number of years I have come to this conclusion, that where water is good, the effect of storage is very slight. I am speaking now entirely of surface water from a river or pond which is freely exposed to the light and air; of course the effect on ground water is entirely different. Ground water or filtered water we must exclude from consideration to-day. It was thought when the Sudbury was introduced, that basin 3 would yield the best water. It drains the quickest watershed, and has not such large swamps as basin 2, but it has turned out far worse; and the reasons for this become perfectly clear upon a thorough study of the analyses and the drainage from Marlborough. The change in the nitrogenous matter and in the color is greater than in basin 2. In fact, there is no change in basin 2 at all in color, and there is no change in the albuminoid ammonia, or in the nitrates or the nitrites. There is a little change in free ammonia; but that is about the only change, and you may say that the water which comes into basin 2 and is stored there for a month is practically not changed at all.

Lake Cochituate is three miles in length and covers 800 acres. It has an immense effect in purifying the waters which flow into it. This is determined by examining the profiles of analyses covering many years and noting the changes in the influents and effluents. It will be found that the line representing the effluent water is straight, with very few fluctuations; while the line of the profiles of the influent water is very irregular, and contains larger percentages of

nitrogen in its earlier forms. That is to say, the effect of this large body of water, with exposure to the air and light, is most beneficial. I think we can say in a general way that where water is bad, the effect of storage is good; and that where the water is good, the effect is very slight.

I should like, if we had time, to go still further into the details of this subject, but it seems to me it is unnecessary, especially as you have already had so many figures before you.

After the water is taken from our large storage basins by the aqueducts, it is carried into Chestnut Hill Reservoir, and there the effect of further exposure is to render the water more uniform in quality. The exposure it there undergoes gives it a more stable condition, the color is improved slightly, and its condition when it goes into the pipes is such that there is practically no organic matter present undergoing decay, or in sufficient amount in an inorganic state to render it deleterious to health. I should add, in further explanation, that this reservoir contains a mixture of all our waters.

I have an idea that the effect of ice upon the surface of a reservoir is to check these improvements in the water to which I have alluded. Some years ago we ran some very bad-smelling water into Chestnut Hill reservoir in the autumn, and we kept it bottled up there. It remained bad all winter, but the moment the ice broke up in the spring the water improved with wonderful rapidity. The gases of decomposition seemed to have a better opportunity to pass off. (Applause.)

SHERBURNE, N.Y., Dec. 8, 1890.

Editor Association Journal, Boston, Mass.: —

DEAR SIR, — Your invitation to prepare a paper for publication in the Journal was not received in time to prepare a paper, or rather to give the convention some experience that I have had the past season in removing about 700 ft. of conduit pipe from one ditch to another without taking each joint apart, so I send this communication, to be used as you see fit.

It may not be anything new to some of the older members of the Association, but was, I must say, new to me. It was desirable to make the moving of the pipe as quickly as possible.

Our conduit line, after leaving the reservoir, follows a rocky ravine for about 1,000 ft.; the pipe was originally laid in the bed of the brook. Below where the pipe line leaves the brook we had a drain built, to retain the deposits which the brook brought down, and the pipe was laid in this deposit.

Last spring the drain was carried away in a spring flood, which undermined our pipe for about 300 ft. It became necessary to move the pipe to some safer spot, and accordingly it was decided to cut a shelf in the rocks or ledge and put the pipe on this shelf.

After the shelf was excavated, ready for the pipe, the work of taking up the old line and putting it in its new place, I came to the conclusion that taking each length apart was going to take too much time; we could not be without water so long, and therefore I concluded to move the pipe in sections of about 75 or 100 ft. I made a jack, and by using two jack-screws was able to pull the lengths apart. I raised the pipe from its bed, placed timbers under it, and rolled it all

up into its new bed, excepting the last twenty-three lengths, which I moved altogether.

After the twenty-three lengths were over the new ditch, I commenced to lower the pipe at the lower end; by so doing the pipe was crowded together at the joints, making them as close as when they were first laid.

The time occupied in doing this job was twenty-four hours, which was considered very good time for "greenhorns."

Would be pleased to be present at your coming meeting, but cannot conveniently do so.

Yours very truly,

W. E. DAVIS,
Superintendent.

SHERBURNE, N.Y., Jan. 26, 1891.

MR. ALBERT F. NOYES, *West Newton, Mass.:* —

DEAR SIR, — Yours of the twenty-third is at hand. I will try and answer your questions briefly: The pipe is a 10-in. cast-iron, manufactured by Warren Foundry, N.J.; it is their ordinary cast-iron pipe. The depth of lead joints being about 2 in., and the weight of each length being from 650 to 700 lbs.

I see by the copy of my first paper it is made to read *drain*, where it should be *dam;* this dam was washed away early in the spring by settlement of the pipe, and in one place the pipe was pulled apart. I brought the ends together again and connected it; this had to be done in the brook, in which the water was high and running like a mill-tail. A while after, we had a very hard rain; this time seven lengths of pipe were washed down stream for several rods; we brought the pipes back and put them in place so we could have water while deciding upon a plan for permanent location. The commissioners thought best not to rebuild the dam, but put it in the rocks, as mentioned in my first letter. I used powder and dynamite, which did very good and expeditious work.

I commenced in the morning of one Saturday, at 6 o'clock, with the intention of working throughout the night; but rain coming on, we abandoned it until the next morning.

I received a letter from Mr. Holden, of Nashua, a few days ago, making inquiries about this same matter. You know we who live in the country and have charge of any such works have to resort to all kinds of ways of doing work; and, besides, our people expect us to be able at all times to do any kind of work, and this gives any one who has charge quite a little experience. Our system is gravity system, and our works quite small, but I am in hopes of getting something larger some day.

I am pleased to hear from the members at any time, and am in hopes to meet at the next annual meeting.

Truly yours,

W. E. DAVIS.

The PRESIDENT. — These papers are now open for discussion, and I hope the members will speak without being called upon.

Mr. HAWES. — Our young and experienced friend, Mr. Jones, would be glad to say a few words.

The PRESIDENT. — We will be pleased to hear from Mr. Jones.

Mr. JONES. — I have had considerable experience in separating pipes in different ways, and when the subject was brought up at the close of the last meeting I made a few feeble remarks, in which I intended to convey the idea that it would not be a difficult matter to separate pipes if the bells and the spigot ends of the pipe were properly constructed. When I went out, some one asked me the question if by putting on sufficient power they could not be easily separated. That is a pretty difficult question to answer, but Mr. Forbes came to my relief, and said he had tried it himself by putting on four jacks to separate a 6-inch pipe, I think he told me, — he is here to answer for himself, — and that he did separate the pipes. But it was a good deal like the story I once heard of a quack doctor who had found out a new-fangled plaster which would take off a sore. He tried it on a negro's heel for an experiment, and took off the sore and the heel too. (Laughter.) So Mr. Forbes separated the pipes, but broke the pipes in separating them. It occurred to me to give a little experience of mine this afternoon, but I see you have a good many papers, and I don't know as I ought to take your time.

The PRESIDENT. — We would be glad to hear Mr. Jones' experience at this time.

Mr. JONES. — With regard to separating the pipes on Tremont street, in 1859, we took up about 40 or 50, I think, 40-inch pipe, and we burned them out. In burning them out, there were one or two of the pipes cracked; but it was the easiest way to take them out, and that was all the harm that was done to them. My next experience in taking out pipes was at Chestnut Hill reservoir, where we took out some 48-inch pipes. Those which were burned out on Tremont street were very hard to separate even after burning, because there would be a little lead left; so at this time I concluded I would be particular about it, and be sure and have the fire hot enough. We got together a lot of good, dry stuff, enough to make a very hot fire, and I was pretty sure that when we came there the next morning we would find them all burned out; and they were. I never knew before that wood would melt iron, but this fire was so hot it melted a few of the bells in the ditch.

Now, if a bell is larger on the inside, and the pipe enters through, and the joint is made strong, I think it would be a very difficult matter to separate them, as I said before. There are circumstances where caps have blown off, post hydrants have blown off, and so much so we put them on with a set-screw, which I think is the practice at the present time. I have a plan of something here which I think would obviate the difficulty. I call to mind two little incidents which I could not account for, and with your permission I will relate them. In 1859, in laying the 40-inch pipe on the Common, there was a branch left to be continued the next spring. That branch was capped with a 40-inch cap, and strapped on so it would not fall off. Going in the spring to lay the pipe, to get the cap off, instead of melting it out, or beginning to melt it out, I put a bar of iron some two inches and a half square between the bell of the cap and the bell of the pipe, and I took steel wedges and wedged as hard as I could to drive it out, but I couldn't start it. I then put on the pressure of the water,

which was about 40 pounds to the inch, making, I think, something like 52,000 pounds pressure — I should say about 25 tons. That did not blow it off, nor could I get it off by these wedges, which every one knows are very powerful — these steel wedges; and I had, as a last resort, to put a fire under it, and I got it out by melting it out, of course.

My next experience with anything as large as that was with this same cap that I took off there. A few years ago when we raised the pipes on Brookline avenue, we separated the pipes, taking out a portion of one, and putting this cap on to the water end, so as to supply a small territory in the vicinity; and for fear it would come off I put up against the pipe a sheathing of 4-inch plank, battened it with a 6-inch square stick, and then pressed that against the cap. I thought it was sure for a while, but along towards night I felt a little cowardly about it, and so I put a man there to stay through the night for fear it would come off. In the morning I went out feeling I had put the man there without any occasion for it, but I found the cap off, all the same. I found that the pressure had broken the sheathing and the cross-plank I had put there, and the cap lay down in the ditch. Now, there was the same cap put on, and very near the same pressure. One time it would come off of itself because I didn't want it to, and the other time it wouldn't come off because I did want it to.

In raising the pipes on Tremont street, in 1865, about a mile, up at Newton street we had a 4-way branch; one branch was connected and the other disconnected with caps. The cap was strapped on with bolts, I think about seven-eighths of an inch in diameter; but when I came to look at those straps I found there wasn't the strength of a three-eighths rod holding the cap on, but the cap didn't come off. That gave me reason to think, and good reason to think, it was a good plan always to put a much larger bolt in the ground than is necessary at the time, for the moment we put anything of that kind into the ground, that moment it begins to decay; and so in the future, up to the time I left, I always put in as large as an inch and a quarter or an inch and a half — something of that sort.

Mr. Forbes. — The case alluded to by Mr. Jones was a line of 8-inch pipe which had been laid but two or three years, and the pipe was so new I didn't want to burn out the joints, if I could help it, so I tried to pull them apart in a way quite similar to the one described here. I worked about two days, and I managed to get apart, I guess, about six or eight pipes, and on two-thirds of those I broke the bell off, or broke the spigot end off. I had four jacks, and I would literally pull the bell off before I could pull the pipe apart. These were made in the usual way — a 3-inch bell. I finally lined up one end of the main five or six feet, and by putting in a 6-inch timber eight or ten feet long, and putting eight or ten men on the end of the timber, and jouncing it up and down, I turned them out without breaking the bell any.

Mr. Allis. — Will Mr. Forbes tell us how much lead there was in his joints?

Mr. Forbes. — These bells were three inches long, and we had an inch and a half of lead in the bell, or supposed we had. The bells were made slanting; instead of having this lead seat formed with a little ring on the inside of the bell, the bell was tapering; it tapered from an inch on the outside an eighth of an inch, and then came up the other half, and we were supposed to have an inch

and a half of lead in all the bells, and I could not pull them apart without breaking. I had on four jacks, and bent up bars and everything else, and broke one or two jacks in the operation.

THE SOFT ANSWER.

BY

L. H. Gardner, Superintendent Water Works, New Orleans, La.

We need go back but a few years in memory to rehabilitate the autocrat of the hotel office. He of the big solitaire diamond and faultless shirt-front; a personage whom we approached with bated breath and with hat in hand while we awaited his dictum consigning us to the cellar or to the attic. How we did wish at such a fateful moment that we had brought letters of introduction to his majesty the clerk, as we tremblingly inscribed our signatures on the register. And having thereafter, by dint of careful assiduity and well-timed attentions, achieved some consideration at his hands, how gladly we accepted his notes of commendation to his fellow autocrat at the next hostelry where we expected to sojourn.

To some extent this gentleman is a type of an almost extinct race of public servants. It remains true that public servants to-day are still human, are sorely patience-tried, and liable, almost unawares, to fall into a groove or manner of carriage and address which runs not parallel with courtesy, good breeding, good manners, or the sort of kind consideration for others which is deemed characteristic of gentlemen. The writer hereof desires to take to himself this homiletic reminder.

There is perhaps no calling in life more patience-trying than that of a Superintendent of Water Works. None that makes more demands upon nervous energy, if he be at all active in the details of his work, or if he be, as is usual, the real manager and responsible officer of the department. It is entirely possible for this gentleman to play the autocrat. I simply say he has abundant opportunity for assuming the rôle, for the temptation is strong, and he has rules, regulations, the *ipse dixit* of a Board of Directors, or the provisions of a City Ordinance to fall back upon, and need vouchsafe no further information than these provide to a complaining subscriber.

The travelling community has access to time-tables and other printed information as to the movements of trains and steamers. Notwithstanding, some spinster will, now and again, ask the ticket agent, "When does the 3.45 train leave?" and he should always pleasantly answer, "At a quarter before four o'clock, madam, unless some accident occurs."

An approximate idea at least, is easily attained, of values for all commodities, and for all manner of rendered service, except in connection with water. The rules of business and the amenities of life are fairly understood in all their departments, but in the purveying of water is found a business, *sui generis*.

Each water-taker is to himself or herself, an Adam or an Eve, — the first and only persons with whom a water official has ever had to deal, — and it is on that basis that each such individual expects consideration. Or, if that position be not assumed, then the special grievance or exorbitant charge for service which

may be complained of, is wholly and entirely different from any other that could possibly be cited.

Each and every one of these people must be treated in a different manner, but each with deference and serious regard. The temptation is to cut off discussion by citing similar cases and their decision, and to close with a clincher embodying a rule or ordinance. Possibly, this may sometimes save time, but not always. If it does, the time is dearly bought, and the visitor goes out dissatisfied and peppery, and the Superintendent turns to his desk with ruffled feelings. (This is more particularly and precisely the case if the visitor be of the female persuasion.)

I am far from saying that interviews of this character can be avoided, — but I think that to a large extent they may be.

Under no surroundings or circumstances is a water service popular, or its purveyor other than an Ishmael.

The complainant enters the water office bristling. The set quills are barbed with sarcasm, contempt, ill-concealed rage, or out-spoken anger. The Superintendent recognizes all the portents and signs, and knows exactly what is coming before a word is spoken. But he is master of the situation, if he chooses to be master of himself. His great trouble is, that his patience is now worn threadbare by a hundred trivial previous vexations during this self-same day, and this one now approaching, seems the last feather upon the camel's back.

Easy, now, my brother! Call down your topsails. Double reef the lower ones. Go slow. No, don't go at all. Keep still, and listen, even if you know the whole story before it is told. In the instant case you finally recognize, to all appearance, a new subject of complaint, and one for interesting inquiry and investigation. Remember that your visitor knows nothing whatever of water rules or rates. Possibly, some of your subordinates have behaved in an improper manner. You will look into the matter at once, and having all the data at hand, you do so.

You then assume the position of mediator between the water department and a suffering public. If there be any correction or concession possible, make it promptly and cordially — but never apologize in an obsequious manner. If, as is more probable, the complaint is of the average sort, don't let your sympathy abate, but for the five-thousandth time, and just as if your speech were made for this especial occasion, go patiently into detailed explanation.

You will perhaps note a corrugated brow, or a curling lip, or a flashing eye. Never mind that. Keep right on and tell that these troubles are incident to the water business the whole world over, and they are wholly unavoidable. It was only the other day that you heard of a similar case in Philadelphia, etc., etc. (*ad libitum*). Get round upon the weather or some local topic. *Keep your temper.* Play the case as you would a fish on your line. And if you don't know what this involves, why, you have something very pleasant to learn.

Some such management as this will involve fifteen or twenty minutes of time. That's what you are there for. It will result in a large majority of cases, in a triumph to you, and a pleasant glow of exhilaration. Your visitor will leave the office mollified if not entirely satisfied, and prepared to yield gracefully to the inevitable. You will not have made an enemy for yourself or for your company — but perhaps a friend. This, whether your complainer be an humble washer-

woman or a wealthy manufacturer. The latter is more easily dealt with. The poor, and therefore (for the main part) the ignorant, will try you most sorely, and they most deserve your sympathy and consideration.

Finally, beloved brethren, remember that public opinion is a jury always in session. Be worldly wise in a high sense. Bad as the world is, it recognizes justice. Rough as it often is, it bows in obeisance to courtesy and politeness.

In all patience be true to your own instincts as gentlemen, and your companies will be richer, and, above all, you will have a serenity of mind, a place in the popular heart, and, with fewer wrinkles and gray hairs, your days will be lengthened ere you come down unshod to the shore of the great sea of unmeasured waters.

THE CARE OF WATER MAINS IN RELATION TO THE QUALITY OF THE SUPPLY.

BY

GEORGE F. CHACE, Superintendent Water Works, Taunton, Mass.

Much attention has been given in recent years to the conditions which affect the quality of a domestic water-supply; and when the quality is bad, or even doubtful, sanitarians are earnestly seeking to point out remedies, and to have them adopted.

The circumstances which modify the quality of a drinking-water are so varied and complex, that chemical and biological analyses, however thorough and scientifically accurate, lose much of their value in the production of practical results, unless they are supplemented by a thorough knowledge of local conditions and an intelligent application of proposed remedies, adapted to special evils.

It therefore becomes the duty of a superintendent to acquaint himself with the quality of the water-supply under his charge; to know whether complaints of bad water are due to general or to local causes; and whether those causes are constant, periodical, or only occasional. For to attempt the cure of evil effects in a water-supply, without knowing anything of their causes, is as unscientific and delusive as the practice of a certain school of medicine which professes to cure disease by doctoring symptoms. The evils may disappear for a time, in the one case, as may the disease in the other. In both instances, nature effected the cure, notwithstanding the impotence of childish experiments, miscalled art. In such cases, a return of the evils may be followed by an utter failure of applied remedies.

It may, therefore, be of some interest to the Association to hear a very brief account of three years' personal experience with the Taunton city water-supply. A careful study has been made of the recorded chemical analyses of the State Board of Health, both of the city water itself, and of Taunton River, which serves as a supplementary supply.

The territory about the works and along the banks of the river has been explored. The past reports of the Water Commissioners have been studied in

relation to periods of unsatisfactory quality of the water. A book of complaints has been kept, in which has been recorded in parallel columns the streets and numbers from which complaints have come of bad water, and the means taken to remedy the difficulty, with the apparent result of the attempt. Microscopical examinations have been made of the water in the filter-basin at different periods, especially during the summer months; of the water at "dead ends;" and of the sediment issuing from the blow-offs, during flushing. For the sake of clearness, it may be stated that the source of supply is ground water, flowing into a basin shaped like an inverted frustum of a quadrangular pyramid, holding, when full, about 1,500,000 gallons. Into this basin empties a brick conduit, egg-shaped in section, and about 1,000 feet long, the bricks laid in such a manner as to permit the passage of water. This conduit runs along the bank of the river within a few feet of the stream, and receives water from both the river and the inland side. At the extremity of the conduit, farthest from the basin, are three eight-inch pipes connecting the conduit directly with the river, except that the water passes through a filter of broken stone before reaching the conduit. These pipes may each be closed by Chapman valves. A ten-inch pipe near these affords opportunity for direct communication with the river, with nothing to impede the flow of the water except when the valve is closed. A large wooden gate in an ordinary brick gate-house affords the means of cutting off the end of the conduit containing this pipe arrangement from the rest of the system. From the basin the water flows into a screen chamber, from which it runs through a thirty-inch pipe to a pump well in the cellar of the engine-house, whence it is conveyed to the consumer by the Holly system of direct pumping.

On the whole, the quality of the water is excellent, except during the summer months, when the level of the basin is low, and there is considerable vegetation, micro-organisms being abundant.

During the winter, the analyses indicate good water, the color is very slight, complaints are rare, and almost wholly confined to consumers near "dead ends." Sometimes after heavy rains there is an increase of color, but no serious fault is found. Throughout this period, micro-organisms are extremely rare, and all the river-gates are shut.

In the late spring, within forty-eight hours from the time the three eight-inch river-gates are opened, somebody is sure to inquire what makes the water so yellow. The increased ratio of river water is, of course, the occasion.

In the hottest days of summer the daily papers report much complaint of disagreeable taste. These reports are, in part, the exaggerations of zealous reporters eager for an item; and, in part, they are true. Some persons have accused the water of giving them disorders of the bowels. Complaints come in from "dead ends" where flushing has been for any cause neglected. Sometimes after fires, or after the filling of pipes of new extensions, there are reports of rusty water in localities adjacent to the fires or extensions.

It seems obvious that a generally unsatisfactory condition of the supply is due, either to the condition of the basin through which all the water must pass before reaching the consumer, or to a generally unsatisfactory condition of the mains. Local complaints must arise from local causes.

An experiment was tried last summer which proved to be efficient in improving the drinking quality of the supply, as a whole. By means of the direct ten-inch

river-pipe, the level of the water in the basin was not allowed, except for a short time, to fall below a certain depth which experience had shown to be the limit for a palatable water. In previous years the ten-inch gate had not been opened, except when absolutely necessary to provide water enough to supply the pumps. Last season the amount of vegetable matter was much less, and people remarked that the water tasted much better than during the summer of 1889. They supposed less river water had been consumed, instead of much more than usual. This, however, did not prevent local complaints. A very few examples will illustrate the situation.

In one of the suburbs of the city is a line of six-inch pipe about a quarter of a mile long, with few consumers, and running to a "dead end." One of the commissioners reported at the regular Saturday evening meeting that a gentleman living very near that "dead end" complained of the abominable water he was obliged to use. The commissioner fully agreed with the gentleman in regard to the character of the water. He tasted it. It was true that this "dead end," in common with others, had been flushed once a week; but the line was so long, with so few services, that the water remained good about twenty-four hours after the flushing, and was then as bad as ever.

The Superintendent suggested that the difficulty could be remedied if the commissioners would authorize the necessary expense. His proposition was to tap in with a small pipe near the "dead end," set up a drinking-trough, and thus keep a small stream constantly running, which would not only keep the water in the main good, but otherwise be of some practical use. This plan was adopted, and gave such satisfaction, that not only did the previous consumers express their pleasure at the result, but very soon there were applications for new services near this very "dead end."

Last summer there was a bad leak in the twenty-inch main. During repairs a section of this main was emptied. The variations of pressure, incident to emptying and refilling, stirred up the sediment in the bottom of the main. Of course this might fill the current when the water reached the smaller mains. The leak occurred on Friday. On Sunday complaint came by telephone from a gentleman living on a side street, which had a six-inch pipe leading from this twenty-inch main, and almost directly opposite the point where the leak had occurred, that the water was black and thick as molasses. He had run a stream for hours through his service pipe, without improving matters. The question being asked how long the water had been in that condition, the answer was, ever since the leak in the twenty-inch main.

The Superintendent went in person and opened a hydrant near the gentleman's house. In about ten minutes he had clear water, and there was no more trouble on that street.

It is customary, at least once a year, to have a general flushing scheme, conducted in the night, when the demand for water is at a minimum. This scheme empties and refills all mains in the city, section by section, by means of the various stop-gates and blow-off gates. The blow-offs empty into the various streams in different sections of the city. The next morning, the "dead ends" are blown off, one after another, and they are blown off throughout the warm months once a week.

When bad water is reported in special localities, the Superintendent investi-

gates the matter; and if he finds the dissatisfaction is upon a long line of pipe with few consumers, or that extensions or accidents in the neighborhood have stirred up the sediment, he studies the map of the pipe system, and either directs the opening of a hydrant near the source of the trouble, or, if the circumstances are such that he thinks such a proceeding might create trouble in another section, he counsels patience for a few hours, after which the sediment will settle, the water cease to be turbid, and the service return to normal conditions.

The purpose of this paper is to show, that, in order to keep a water-supply in a satisfactory condition, the care of the water mains is quite as important as the care of the reservoir. Imperfectly filtered water always contains more or less sediment. Wherever this sediment accumulates, at the bottom of the mains or at the "dead ends," there is food for the kind of vegetable growth which takes place in the dark. When this sediment is moved by any disturbance of the general circulation, there will be sure to be grumbling from consumers who get dirty water in their service-pipes.

The remedy is threefold.

First, If the water is thoroughly filtered before it reaches the pumps and then pumped directly to the consumer without previous storage of the filtered water, there will be no trouble from sediment.

Second, If filtration is impracticable, then frequent general flushing of the mains is the next best proceeding.

Third, Where general flushing schemes are impossible from scarcity of water, or from the crowded character of the city, so that demand for a large supply is constant, local flushings, especially at "dead ends," with perhaps small streams kept flowing at the worst points, must be the resort.

Doubtless the experiences and suggestions here set forth are very familiar to many of you. If anything has been mentioned which may prove to be of service to a fellow-member in performing his official duty, the writer will feel justified in having accepted the invitation "to prepare a short experience paper."

DISCUSSION.

Mr. ALLIS. — I would like to ask Mr. Chace how many "dead ends" he has got, and how many miles of pipe, and how many "dead ends" have these gates or flushing arrangements?

Mr. CHACE. — There were fifty-odd "dead ends" until a year ago, when we closed up about twenty of them. The only means of flushing "dead ends" is by a hydrant, which is placed near the end of most of them; and where it is a short line of pipe, a little more than 200 feet or so, there is a small blow-off, so that there is no "dead end" which has not some means of blowing off, either a blow-off or a hydrant. There are about 60 miles of pipe.

AN EXPERIENCE IN CROSSING A STREAM WITH A MAIN PIPE.

BY

E. H. GOWING, C.E.

The problem presented was how best to cross a stream with an 8-in. pipe, under the following conditions: width of stream, at high water, 325 ft., at low water, 270 ft.; greatest depth at low water, 16 ft.; maximum pressure in the pipe, 85 lbs.; minimum temperature, thirty degrees below zero; nature of bottom, part sandy and part ledge; point of crossing, fixed near and just above a covered highway bridge of two spans, the pier and abutments for which are of stone, laid dry.

The engineer, who designed the works and who partly completed them, at first proposed to lay the pipe on an independent truss-bridge which would have been in two spans of about 115 ft. each, supported on abutments, and a pier built on the up-stream side of the abutments and pier of the highway bridge. This bridge was to have been about 3 ft. wide by 4 ft. high, and was to cost $4.25 per lineal foot. Later, this kind of a bridge was abandoned, and a suspension bridge substituted in its place. This was to cross the stream at the same place as the other.

The pipe was to be 8 in. in diameter, in 12 ft. lengths, and flanged.

At the time I was given charge of the work the flange-pipe was on the ground, so that any change that would not allow of that being used meant the loss of whatever it cost.

Believing that in a cold climate a pipe laid on a bridge would, even if carefully boxed, be a constant source of expense and anxiety, an investigation was begun to see if there was not some better way to solve the problem. One of the first results was a firm conviction that a suspension bridge was entirely unfit for the work, and particularly the bridge that had been designed for the place, and finally that "Ward's ball and socket pipe," laid on the bottom of the river, was the best way to cross the stream. In the course of the investigation the following estimates were made: —

Cost of suspension bridge, erected	$980 00
" masonry for same	1,000 00
" laying flange-pipe, including bolts, gaskets, boxing and painting box	490 00
Total	$2,470 00
Cost of a suitable bridge	$3,000 00
" masonry for same	1,000 00
" laying pipe as above	490 00
Total	$4,490 00
Cost of "Ward's joint pipe" as per Ward's bid	$2,100 00
" " " " " estimate,[1]	1,120 00

[1] This estimate included the cost of the flange-pipe that would have to be thrown away.

As the price of the " Ward's joint pipe " laid was very much lower than either of the bridge schemes, and as nothing came up to shake my belief in the desirability of placing pipe out of reach of the frost whenever practicable, that solution was adopted.

DISCUSSION.

Mr. HOLDEN. — I have got to do something similar to that this year, having to lay a pipe across the Merrimac River, some 700 feet in length or more. Instead of putting a pipe under water, I always like to have it where, in case there is a leak, I can find it. My idea was that perhaps an 8-inch wrought-iron pipe had better be laid right across the bridge. We have a highway bridge I can run it across on, if I want to, putting in two or three expansion joints to provide for the contraction or expansion by cold and heat. And why wouldn't either wrought-iron or steel pipe, put together in the ordinary way that wrought-iron pipe is, with couplings and thread, be preferable to cast-iron pipe? Of course there is a little motion to a bridge; I have laid several cast-iron pipes across bridges, and I have noticed the joints will start in time, and most every year they will have to be set up. I propose to lay either wrought-iron or steel, and I have been studying into the matter of steel, which I have never used yet, and I don't know whether it is more desirable than iron or not. By having a wrought-iron pipe, the bridge can jar considerably without affecting the pipe, and the pipe can expand with the expansion joints, and then I would have a double boxing, — the inside box about twelve inches square inside for an 8-inch pipe, and outside of that a box, say, 24 inches square, which would leave about six inches space all around it, and have that filled with tan bark, which is as good as anything I know of; it will never decay, and is as durable and cheap, and certainly a great deal better than sawdust, and a great deal less expensive than felt. I have been intending to lay the line in that manner, unless I can find something better.

Mr. BALL. — If it would be in order to tell what has been done in this connection I should like to say a word. When the Springfield water-works were built in 1874, we had a problem there to accomplish which at first looked rather formidable. Where we were obliged to cross the Chicopee River to get the best line on each side of the river, and to pass Indian Orchard village at such a point as we might make the best possible supply for the village, we had to cross the river where there was a very rapid fall, and nothing but sand rock on both sides and in the bed. After studying the problem for some length of time, I concluded to adopt this method: We built an abutment on each side of the stream, and if my memory serves me right, the clear span between the abutments is 173 feet. There were two 24-inch mains, made of, I think, three-eighths inch boiler iron riveted together in the same manner as boilers are riveted together. Those two pipes were laid level, to form the upper chord of the truss. The truss-work of the bridge, which formed the whole support, was thrown below the two chords, so that when the bridge was finished the two upper chords, which were two 24-inch pipes, were a part of the supporting structure itself. These pipes had, of course, expansion joints at each end. The bridge was finished and the water let into the pipes the last of December, 1884.

I think the 26th or 28th of December we got through. We had no services from the pipe that winter, and so far as I know there was only a single leak, and that was at a swamp two miles towards Springfield, after the water passed the bridge. The pipe was left entirely bare, and I believe is bare to-day. They have never protected it in the least, and our experience with it that winter was that it didn't freeze. We examined it two or three times, and there was never any accumulation of ice in the pipe. There was but one pipe used that winter, the other was left free; that is, so far as Springfield is concerned.

At New Haven, a few years after, I had occasion to pass over the Quinnipiac River, and we crossed in a situation similar to what Mr. Holden speaks of over the Merrimac at Nashua, — by a bridge. I think there were seven spans of 44 feet each. Those spans sustained the road bridge; and in order to go across the river so that the pipes might be independent of the bridge, and not have any of that tremor which the travel over the horse-railroad tracks and the other travel would transmit to the pipes, we laid the pipes entirely independent of the bridge, dropping them upon the abutments. Those pipes were 24-inch, 44 feet in length from end to end, and they were trussed with angle-iron in such a way as to make them entirely self-supporting. The joints on each pier, of course, were laid in a way so that they became extension joints. Those pipes were not covered at the time, and I think they never have covered them since, and they never have had any trouble whatever in the matter of the water freezing in them.

I will mention one other fact which I have seen during my travels around water works, in the matter of water keeping itself free in pipes that are uncovered. Near the city of Greenfield there is a ravine, a narrow gorge cut in the ledges, somewhere between forty and fifty rods in length. When their works were built they put an 8-inch pipe down this ravine. In some instances it was put up on the rocks, and in many instances it was put up on iron supports from three to four feet in height. I was there some six or seven years after it had been in use, and that pipe had remained there entirely uncovered and exposed in this narrow ravine, but it had never troubled them by freezing. I have no doubt that Mr. Holden will find it to his advantage to use either wrought-iron or steel for his pipes across the Merrimac River.

Mr. Holden. — The reason I propose to box this pipe is that it is to supply the small village of Hudson, and probably to start off with we wouldn't have more than perhaps fifty or seventy-five consumers; and in the winter, of course, they will use very little water in the night, and I was afraid that there would be such a slight draught it might get caught. If it was where we had a circulation, I think I could get along without boxing; but in order to save any trouble from freezing I must either have boxing or have an outlet. I have no doubt an ordinary drinking-fountain placed there with a tap-supply during the winter would keep it from freezing, as it does in several places I know where they cross the river. A half-inch stream, I think, would keep an 8-inch pipe from freezing.

Mr. Gowan. — There is one place in our town where it was quite impracticable to lay the pipe under water, so it was carried over a bridge, and it was thought that if they put in an inch opening and left it running it would keep the water from freezing. As matter of fact it did not, but it froze solid and broke one piece of pipe. I think the temperature goes lower at this point than

in Nashua or Springfield or New Haven. I remember when we started to lay the pipes on the bridge that morning the thermometer at seven o'clock was ten below zero, and it has a way of staying in the neighborhood of twenty below zero for several days right along.

Mr. BRACKETT. — With regard to the question that Mr. Gowan has raised as to whether it would be better to carry the pipe under or over a stream, I think it depends very largely upon what the temperature is likely to be. As an example of what may be expected, I can cite a case which has occurred in connection with the Mystic works, where the 16-inch pipe supplying the entire village of Everett, which, I think, has between five and eight thousand people, a few years ago was frozen solid on a bridge where the pipe was laid under the sidewalk, supported on timbers. That pipe was not boxed in any way; but it had never given any previous trouble, although it had been there for seven or eight years at least. Its freezing was a thing I should never have expected. Our large mains are carried over bridges unprotected, and we never have had any trouble with them. Our smaller pipes are protected by either single or double boxing, depending upon the number of takers who are supplied through the pipe, and we depend generally upon a tight air-space rather than upon any filling-in between the boxing; my experience being, or judgment, that you are liable to have leaks on these pipes, — small ones, at any rate, — and if you do, the packing will be saturated with water, and you would be worse off than you would be with a simple air-space, if it is tight.

In some extreme cases we have double-boxed the pipe and filled the space between the two boxes with asphalt, that is, a cold tar asphalt, calculating to make a water-tight box; that is the idea, simply making a dead-air space, for I don't believe that anything is a very much better non-conductor than air, if you can confine it.

With regard to using wrought or cast iron pipe for the crossings, we have on some of our long pile-bridges lines of 20 and 30 inch pipe laid with the ordinary bell and spigot joints; and where we have them laid with the lead scores, there has never been any trouble, with the exception of now and then a slight leak on the joint, but nothing of any consequence, and very seldom any trouble whatever. Where the pipes were laid originally without any lead scores, there was always trouble from the lead starting out. On many of these bridges there is a great deal of jar and trembling. Take, for example, the bridge which you may all know of between the city proper and Charlestown, where there is as much travel, probably, as almost anywhere in the United States, and the pipe there has been laid for a good many years, and we have never had any trouble from it.

The wrought-iron pipes which we have in use are most of them comparatively short, crossing railroads ordinarily, lines of pipe from 50 to 75 feet in length, I should say, and where we wanted to avoid using cast-iron curves at the ends of the bridge. In some of the first pipes which were laid the bends were made with the wrought-iron and all riveted together solidly. Those gave trouble, I think, full as much by the settling of the cast-iron pipes at either end, as by the contraction and expansion, although that may have had some effect. At any rate, these pipes have since been given up, and the cast-iron and sleeve used at either end of the bridge; and in all new cases they are all made in that way.

To the superintendent who has the maintenance of the work a pipe laid over a stream is much more accessible, and I think he feels safer than he does when it is underneath, if it is practicable to lay it above and keep it from freezing. If the pipe is under the stream, if there is any trouble with it he is dependent on a diver for repairs, and it is not always an easy thing to do. We have one line of 6-inch Ward joint pipe, and also a line of 20 and 24 inch, which are laid with a swivel joint. There are also two 8-inch lines across Shirley Gut, from Deer Island to the mainland. Those were put in, the water being very deep and the current very rapid, by being drawn across from one side to the other by a windlass. A chain was carried across from one shore to the other and the pipes put together, length by length, on the beach, and then drawn across, depending upon the strength of the joint to pull the pipes across. The pipes were tested after being laid by meter, and I think found perfectly tight.

Mr. HOLDEN. — Was it an ordinary joint?

Mr. BRACKETT. — No, a Ward joint.

Mr. GOWAN. — In reply to Mr. Holden with regard to the tightness of the joints, I will say that this pipe we had laid was under water about two years, and then the water was drawn off, and I didn't see it myself, but the superintendent told me there were no joints that required caulking then, so I think it was perfectly tight. I see no reason why it could not be made tight. I had a diver there to do a little blasting in the rock before we laid the pipe, and I went down myself and inspected every joint in the pipe, and saw no signs of a leak then; and if there had been, it would have been a comparatively small job to have caulked it at that time.

Mr. JONES. — I will make a remark with regard to the pipes that go across from Chelsea to East Boston; this may be a novel way of remedying a leak underground. It was a 24-inch pipe that crossed the creek, and there was a break there — evidently a break, by the amount of water that came up. Come to find out, it was dredged out so that the top of the pipe was about six feet under the earth, and the earth was twenty feet under the surface of the water, which made it rather difficult, of course, to get at it. Nobody could go there except a professional diver. It was found that in this swivel joint it was broken on the bottom close to the flange, and the question was how to mend it. It was at last mended by driving in some wooden wedges and putting a clamp on them. The diver had to do it, and we had to take his word how well it was done, of course; but being six feet under ground, and the ground, as I said before, twenty feet under the surface of the water, it wasn't a very easy place for the superintendent to get at to mend, himself.

The PRESIDENT. — I will like to ask Mr. Ball if he accounts for the non-freezing of the water in the pipe at Springfield that winter on any other ground than on account of the mildness of the weather?

Mr. BALL. — The winter of 1875 was a pretty severe winter, and several days the thermometer was down to zero, I think. Of course we don't have any such weather as Mr. Gowan speaks of, — sometimes down to ten or fifteen degrees below zero.

The PRESIDENT. — It occurred to me that if it was a cold winter the little circulation due to the leak might have accounted for the non-freezing.

Mr. BALL. — That is all that saved it. If the pipe had been caulked

perfectly tight I should have expected it to freeze, but it didn't, under the circumstances.

Mr. JONES. — Mr. Ball calls my attention back to 1875. That was the most severe winter I ever knew on the water works, and my commencement with the water works was in 1840, and I would like to say a few words with regard to it. It was a very severe winter, and the frost went down into the ground, I know, seven feet deep; but as we had no time to prospect for curiosity's sake, we stopped at that. Main pipes through the streets, where they lay four feet and four feet and a half underground, 12-inch pipes and 8-inch pipes, froze up so we had at one time ten or fifteen streets opened before we could get men who understood the thawing out of the pipes to take care of them. There were some 5,000 service-pipes that year frozen up in the city of Boston. There were 2,000 we could not reach that had to wait till the spring of the year thawed them out. Those were troublesome times to the superintendent, I assure you, and I know it, because I was there myself.

Mr. GOWAN. — Perhaps there is one point that I did not emphasize as much as I ought to, and that is the cost. The estimate for crossing over was about $5,000; my estimate, I believe, was about $1,100, and I did it inside of the estimate. I think that should have some effect in deciding which way to do it, other things being equal. And one more thing, suggested by what Mr. Jones said about the superintendent not going down to inspect the work. From my experience I would not place a great deal of reliance on what a diver tells me when he comes up. In this particular case he went down and reported the surface of the rock-bed of the river as perfectly smooth and suitable to lay the pipe. I went down the first time more for curiosity than anything else, and I decided that the bed of the river was not smooth by any means, and I did considerable blasting, and am only sorry I didn't do more. After the pipe was laid I went down and inspected it again, and I would respectfully advise any one doing any sub-marine work to go down himself and see how the work is done, for I know I look upon the work with different eyes than the average diver does.

Mr. JONES. — I would like to say with regard to my not going down myself, I had no great anxiety or desire to go down; but after the work was done and the divers said it was all right, we put the water on and tested the pipe by meter, and that told the story correctly, whether it was tight or not. We were satisfied by the test that they had done a good job, and that it was tight; and I know it remained so for a number of years, so I suppose that was just as good as it was to go down.

The PRESIDENT. — During the past season, probably but few of our members have had so large an experience in the study of the effect of water upon various materials as our friend Mr. Forbes, of Brookline, and he has something to say to us on the proper materials for well construction.

DRIVEN WELLS AS A SOURCE OF WATER-SUPPLY.

BY

F. F. Forbes, Superintendent Water Works, Brookline, Mass.

Not a few of us have been called to examine the subject of driven wells as the means of making available a water-supply, and any experience in this particular branch of water-works construction cannot fail to be of interest to most of the superintendents gathered here to-day. It often happens that in certain localities where a water-supply for a city or town must be obtained, the only practical way is to drive wells, for the reason that the upper layers may be of too fine material to admit of a filtering gallery working successfully, or the water-bearing stratum is too far below the surface for such form of construction.

The problem before one is to select such materials, and put them together in such a manner, that as the years roll by these wells will not become clogged with rust or fine material, and stop in part or entirely the flow of water. I have given this subject much study during the past two years, and the form of construction which appears to me to be the best will be briefly given in this paper. I will first describe the bottom piece of the well, into which the water from the surrounding gravel must flow. The usual way is to drill a certain number of holes of small diameter up and down the sides of the pipe, which is to form the bottom of the well, for a distance of two feet, more or less, according to the thickness of the gravel layer in which it is to be driven.

Now, the objection to this way is that these small holes are quite likely to rust up, this being hastened by the small gravel stones which are sure to partly fill them.

To obviate such a result the holes were all bushed with $\frac{3}{8}$-in. brass pipe as follows: The holes were tapped out, the brass pipe screwed in till it was flush with the inside, then sawed off with a hack saw and left smooth on outside so as not to be injured by driving.

The expense was not large, one man easily finishing three pipes in one day; and in one case the work was all done by the permanent men during the winter days, or, rather, parts of days, when time could be spared from hydrant inspection, etc., and so really cost the town little.

We next come to the horizontal part of the well, which connects the vertical part with the receiving suction main, or gravity conduit.

This change in direction is made with a tee of easy radius instead of an elbow, for reasons given later. If the well is to be $2\frac{1}{2}$-in. in diameter, into this tee is screwed a $3 \times 2\frac{1}{2}$ reducing coupling, and into the other end of this reducing coupling is screwed a piece of 3-in. cement-lined pipe of proper length, and on to the other end of this 3-in. cement-lined pipe a similar reducer is placed, with a companion flange of a $2\frac{1}{2}$-in. gate. This companion flange forms the union joint. From this valve to the main, a piece of lead pipe is used, or. instead of the cement-lined pipe, lead could be used wholly.

This piece of lead will be found to be very convenient, for if the well is not driven exactly plumb, — a very difficult thing to do in some material, — or the fittings are not tapped straight, the work of connecting these wells air-tight

without the lead will be almost impossible, and also in case there should be a slight settling afterwards, the lead will take care of it.

The reason for the construction last described is to guard against rust. The horizontal part of the well, which is practically impossible to reach after the work is completed, is composed either of lead, brass, or cement-lined iron, — materials which are not likely to be affected soon by oxidation.

Now, into this tee, at the junction of the horizontal and vertical part of the well, an upright piece of pipe is screwed, reaching to the surface of the ground.

There are two reasons for carrying this pipe to the surface. First, to clear the vertical part of the pipe, in case it should rust up; and, second, to examine the well at any time to determine whether or not the amount of water was decreasing.

In the latter case, the valve between the well and suction pipe or conduit can be closed, and the well drilled, washed, and pumped out, as in the first place, and it is probably made as productive as when new.

DISCUSSION.

Mr. Brackett. — Never having had any experience with driven wells, I don't know that I am qualified to say much upon the subject, but there is one point I would like to inquire about, and that is regarding the point used for the well. Mr. Forbes states the holes were bushed with brass. Now, would it be possible to use a heavy brass tube for that point, the reason being this: that the brass in connection with the iron will create a chemical action which will form rust faster, I think, than the iron alone. That is shown by the fact that the brass corporation cocks will fill solid with rust, although they project from half to three-quarters of an inch into the main. If these holes were simply bushed with brass it might improve it; but it is a question whether it would prevent the filling of the holes with rust, and whether it would not be better to make the point with very heavy brass pipe or casting.

Mr. Forbes. — At the bottom part of the well you have to have it, because if you should use ordinary brass pipe I should be afraid it would split in driving. You would have to have a casting made, and it would cost a good deal of money, and be very heavy. A hole drilled through a pipe, in driving is pretty nearly filled up with gravel; small particles of gravel are bound to enter the pipe a short distance, at least, and there seemed to be more danger of the raw iron forming a little crust, or cementing these little particles of gravel together. This brass bushing going entirely through the pipe (and we use double extra heavy pipe for the bottom part, and single thick pipe for the other part) seemed to me to be surer and better than pipes used in the ordinary way. And in case the flowing decreased, this gate could be shut, and the force-pump put on to the well. At least, that appeared to me to be the better way; but perhaps I am wrong. Mr. Noyes has had a good deal of experience in this matter.

Mr. Noyes. — I may say, in addition to what Mr. Forbes has said, that this is a subject I have been a good deal interested in for some twelve or fourteen years. I have had flowing wells similar to what Mr. Forbes described, that have been flowing for twelve years. They were put in with common untarred

and single-thickness pipe, that is, standard thickness, and the holes were about quarter-inch holes reamed out on the outside to three-eighths. I anticipated I should have to clean them out every year for rust and other causes, but I have never had to put a rod into them, or a water-jet into them. This summer we had occasion to go to these wells, and they were flowing, so far as I could judge, with the same volume and in the same manner as they were when they were first driven. I intended, during the operation of the work, to draw some, and see how the ends of the perforated pipe were; but we were so busy, and the work was following us so closely, I could not spare the men on the work till it was too late to attempt it. Well-drivers tell me, that where these holes are reamed out on the outside, leaving a thin shell on the inside, any breaking away only tends to enlarge the holes. The way I have always intended to clear out these pipes was with a water-jet with a force-pump, forcing the water-jet in through a gas-pipe with a drill-rod at the end, the water flowing around the end of the drill-rod, keeping the material stirred up, and it will force out a very large quantity. In fact, in some cases where I have driven into hard-pan, and the flow of the water was very weak, we have spent considerable time in drilling out; we have taken out a large quantity of hard-pan, washing it out, I should say, a barrel or more; and in some cases two or three barrels of the hard-pan has been washed out. It has undoubtedly left a coarser material in the cavity, and rather a large area, and in many of these cases we get a very considerable flow of water. But the well-drivers tell me invariably, and especially the older ones tell me, that their experience is, that this breaks away on the inside, and tends to enlarge the hole rather than to fill it up, and that they never have had any trouble upon that point.

It has been a very serious study with me as to what class of pipe we should use in our work. We found from the results that the water of the Newton water works acted very little on galvanized iron pipe; they have been in service for years, and there having scarcely been any injury on the inside, I decided to use galvanized pipe for the driven pipe. Extra heavy pipe was used for the points in this particular case, and the holes drilled, and it was galvanized afterwards, so that there was no fresh edge which was exposed. When the pipe was cut during the work, it was tarred over with a black varnish, — a varnish which has stood very well on wrought-iron pipe. Of course, we have yet to see what the action will be, but that is the precaution I used in this particular case. I should be most afraid of putting in the brass ferrule, as Mr. Forbes has, from the observation I have had of service-cocks in connection with the main pipes.

Mr. Forbes. — I will say that we have used galvanized pipes, and have had more trouble with them than with any pipes we have to-day. That seems to be about the only thing you can put on a driven well, because the drill and washing-out tools going up and down the pipe, would be sure to tear away anything like tar or enamel. Of course, the galvanizing process leaves a very hard surface, and one not likely to be injured by the tools. But we have had more trouble with galvanized pipes in Brookline than with any other kind of pipe. Every kind of water, you know, varies, and we have never had any trouble with rust forming in our corporations for seventeen years, but we have had a great many wrought-iron pipes rust entirely up. Having had no trouble at all with our water rusting up corporation cocks, as I have heard about in other places, and

having had so much trouble with galvanized pipe, looking over the whole subject, it seemed that for our particular water, the form of construction I adopted would be the best. Of course, we never can tell exactly what a thing is going to do until it has been tried.

Mr. HOLDEN. — I would like to inquire what kind of material is best for driving wells. I remember the first well I ever saw was in 1865, when I was connected with the Hoosac Tunnel. A man came along to North Adams, and drove a pipe down some ten feet, set a pump on to it, and had a never-failing flow of water. Then he went to selling out town rights, got quite a crowd collected around there, and before he had been there a week he had sold out the right to put in these wells in every town in Berkshire County; but after he left, people came to the conclusion that there wasn't another locality in the whole county where they could drive a well with success.

The PRESIDENT. — I will say, in answer to Mr. Holden, that so far as my experience goes, you can use driven wells, only when the strata from which you take the water would be inaccessible from surface excavations under any conditions, and where it is desired to have a well quickly, and at a small expenditure of money.

PEET VALVE CO.,

MANUFACTURERS OF THE

Genuine Double Gate Peet Valves,

FOR STEAM, WATER, GAS, Etc.

Special Valves for all purposes made to order.

Peet Valve Co.,

163 Albany St.,

BOSTON, MASS.

1 Vol. 8vo. 700 pages. PRICE, $3.00.

The Manual of American Water-Works.

1889.

COMPILED FROM SPECIAL RETURNS.

Containing the History, Details of Construction, Source and Mode of Water Supply, Pumping Machinery, Distribution, Consumption, Pressure, Hydrant Rental, Revenue and Expenses, Cost and Debt, etc., etc., of Every Water-Works in the United States and Canada. Also:—

Directory of Water-Works Officials, *with addresses.*
Water-Rates of each City and Village in the United States.
Illustrations of notable Dams and Reservoirs.

M. N. BAKER, Ph.B., Editor.

WHAT IS SAID ABOUT IT.

"Permit me not only to thank you for the Manual received a few days ago, but to say that, in my judgment, I do not see how a water board could conveniently dispense with its use."—A. H. HUBER, *Sec'y Westminster (Md.) Water Co.*

"The book is too valuable to any department to delay giving needed information, and prompt response should be given."—JNO. R. TODD, *Registrar Norfolk (Va.) Water-Works.*

"I have received your Manual of American Water-Works for 1888. Just the thing I wanted; full of statistics and information. A big thing for small money. Put me down for next (1889) issue."—FRED ALSTERLUND, *Chief Engineer and Superintendent Moline (Ill.) Water-Works.*

"I am in receipt of your valuable book on water-works, for which please accept my thanks. Please send me another copy, and bill for same, as soon as possible."—JAMES P. DONAHUE, *Sec'y Davenport (Ia.) Water Co.*

"We have your Manual of American Water-Works. We find the work complete, and the most satisfactory ever published."—THE MICHIGAN PIPE CO., *Bay City, Mich.*

"I consider the Manual of Water-Works WORTH $100 A COPY to any concern dealing in water-works goods or supplies."—*Holyoke Hydrant and Iron Works*, C. E. TORRANCE, *Proprietor.*

NEW FEATURES OF THE 1889 MANUAL.

A COMPLETE TABLE OF WATER RATES, giving rates for metered water, dwellings, bath-tubs, stables, etc., etc., for each city and village in the United States and Canada.

ALSO ILLUSTRATIONS OF WATER-WORKS DAMS of various types, and much additional text regarding dams and reservoirs.

PLEASE REMEMBER that our yearly returns are from official sources, with previous descriptions of the various works corrected to date.

We include and describe every public water-supply plant in the United States and Canada, and list those works that are for fire protection only.

We are in communication with every water-works engineer and contractor of note in the country, and have all the most important daily papers, and thus learn of every new project and every new water-works. We collect information regarding all new works.

IF YOU MANUFACTURE OR SELL any kind of water-works supplies, the advertising pages of the MANUAL are a good medium to reach your customers. In any case you will find it a valuable and handy book for reference and general use.

Published and for sale by

ENGINEERING NEWS PUBLISHING CO.,
Tribune Building, New York City.

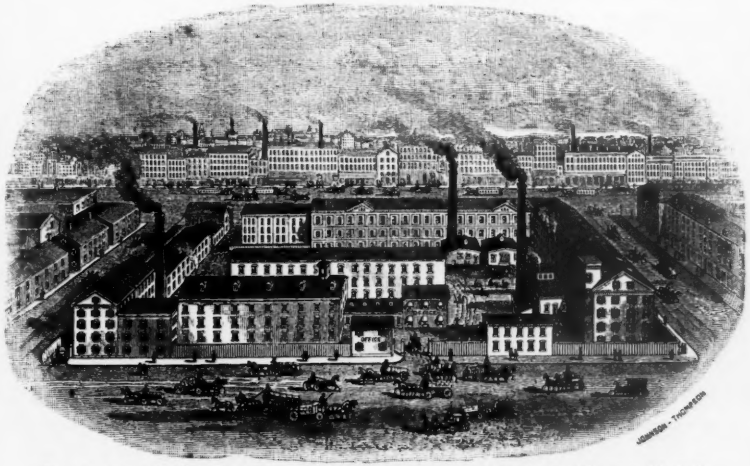
The 1888 Manual is on Sale at $3 a copy.

BOSTON BELTING CO.,

ORIGINAL MANUFACTURERS OF ALL KINDS OF

VULCANIZED INDIA-RUBBER GOODS.

ESTABLISHED 1828.



Factories of the Boston Belting Company, Boston, Mass., U.S.A.

OLDEST AND LARGEST MANUFACTURERS IN THE WORLD

OF

RUBBER BELTING.

RUBBER PACKING.

Also Manufacturers of all other articles of VULCANIZED INDIA RUBBER for Mechanical and Manufacturing purposes. RUBBER VALVES of all descriptions for Hydrants, Pumps, Engines, Steamships, etc.

RUBBER HOSE.

Warerooms.

256-260 Devonshire St.,
BOSTON.

100 Chambers St.,
NEW YORK.

EUREKA FIRE HOSE CO.

No. 13 Barclay Street, New York.

THE LARGEST MANUFACTURERS OF

RUBBER LINED COTTON HOSE

of all Descriptions, in the United States or elsewhere.

Sole Manufacturers of the Celebrated Brands of Seamless Woven Cotton, Mildew Proof and Rubber Lined

FIRE DEPARTMENT HOSE.

"EUREKA," a Triple Hose. **"PARAGON,"** a Double Hose. **"RED CROSS,"** a Single Hose.

Manufacturers of HOSE of every description.

SOLE MANUFACTURERS OF

"EUREKA UNDERWRITERS"

BEST LINEN HOSE,

made in accordance with the requirements and specifications of the

Associated Factory Mutual Insurance Companies for Factory Linen Fire Hose.

Every length of the "Eureka Underwriters" Best Linen Hose will have a special woven trade-mark, *Red, White, and Blue*, woven in, and branded with black letters every fifteen feet, and with serial letters from A to L, which represent the months January to December, and year of its manufacture, so the genuineness and date of its manufacture can be assured.

"U.S." BRAND Cotton Rubber Lined Factory Fire Hose.

This brand of Rubber Lined Cotton Factory Fire Hose was made in accordance with the recommendations of Mr. JOHN A. FREEMAN, Hydraulic Engineer and Inspector of the "Associated Factory Mutual Insurance Companies" of Boston. In addition to its being branded "U.S.," every length will have a special mark, *Red, White, and Blue*, woven in, to distinguish it. All parties desiring a first-class and reliable Factory Fire Hose should specially require the "U.S." brand, and accept no other.

SAMPLES AND PRICES ON APPLICATION.

EUREKA FIRE HOSE CO.,

P.O. Box 1330. **No. 13 Barclay St., New York.**

82,000

WATER METERS MADE AND SOLD BY

National Meter Company,

JOHN C. KELLEY, President,

252 Broadway, NEW YORK. **New England Agency, 159 Franklin St., BOSTON.**

DECEMBER, 1890.

AUTOMATIC SUPPLEMENTARY OR DOUBLE VALVE

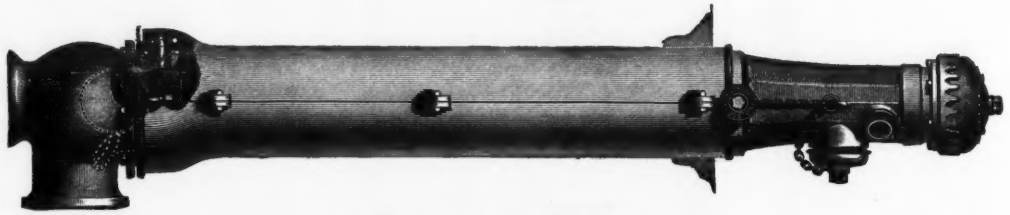
FIRE HYDRANTS.

Also Constructed with

Single Main Valve.

Formerly built by the Boston Machine Co., and Boston Machine Mfg. Co.

(CARR'S PATENTS.)



Manufactured only by

CHARLES CARR,

(SOLE OWNER OF PATENTS.)

OFFICE, 7 EXCHANGE PLACE, - - BOSTON, MASS.

CARR'S

HYDRANTS.

THE POPULAR AND DURABLE

E. R. JONES'

TAPPING MACHINE

No other equals it in efficiency or durability,

AND

The following are among the cities and towns using this Tapping Machine: Auburn, Bangor, Bar Harbor, Brewer, and Old Town, Me.; Dover, Littleton, Nashua, N.H.; Morrisville, St. Johnsbury, Waterbury, Vt.; Boston, Brookline, Cambridge, Charlestown, Clinton, Everett, Fall River, Fitchburg, Holyoke, Haverhill, Lowell, Lawrence, Leominster, Marlboro', Maynard, Milford, Newton, New Bedford, North Adams, North Bridgewater, North Attleborough, Norwood, Springfield, Taunton, Waltham, Westfield, and Worcester, Mass.; Pawtucket, Providence, Westerly, R.I.; Norwich, Conn.; Hornellsville, Hudson, Mt. Morris, Norwich, New Berlin, New Rochelle, Oneida, Oswego, Rochester, Troy, and Yonkers, N.Y.; College Point, Flushing, and Long Island City, L.I.; Atlantic City, Bayonne, and Jersey City, N.J.; Norristown, Penna. Steel Co., Sayre, Pa.; Wilmington, Del.; Cincinnati, Columbus, Dayton, Ironton, Martin's Ferry, Portsmouth, Sandusky, and Toledo, Ohio; Belleview, Covington, Henderson, Maysville, and Newport, Ky.; Evansville, Ind.; Jackson, Mich.; Milwaukee, Wis.; St. Joseph and Sedalia, Mo.; Jacksonville, New Orleans, La.; Salt Lake City, Utah; Sacramento, Cal.; Fredericton, N.B.; Barbadoes, W.I., and many others.

DUPLICATE PARTS FURNISHED.

Carr's Patent Automatic Supplementary or Double Valve Hydrant,

Always Reliable and Operative. Also Single Valve Hydrants. Manufactured only by

CHARLES CARR,

SOLE OWNER OF PATENTS.

Office, 7 Exchange Place, Boston.

R. D. Wood & Co.

Engineers,
Iron Founders,
and Machinists.

Office: 400 Chestnut Street, Philadelphia.

FIRE HYDRANT
WITH CRANE ATTACHMENT FOR SPRINKLING CART.

Foundries and Works: { MILLVILLE, FLORENCE, CAMDEN, } N. J.

Constructors
of
Water and Gas Works.

MANUFACTURERS
—OF—

CAST IRON PIPE

TURBINE WHEELS,

Pumping Machinery,

Hydraulic Cranes,

Lifts and Machinery,

Heavy Loam Castings,

"Eddy" Valves,

"Mathews'" Hydrants.

The American Frost Meter Co.,

OWNING AND CONTROLLING ALL

VERTICAL PISTON METERS.

These Meters are the most DURABLE, ACCURATE, and RELIABLE Meters built — requiring no repairs or attention, and will register accurately on the finest stream. They are the only Meters which received the unqualified approval of the Meter Testing Commission of the city of Boston.

82, 84, 86, 88, & 90 Lenox st., Boston, Mass., U.S.A.

P.O. Box 3659. Write for Circular and Price List.

CHADWICK LEAD WORKS,

Nos. 176, 178, 180, 182, and 184 HIGH STREET (Fort Hill Square),

BOSTON, MASS.,

MANUFACTURERS OF AND DEALERS IN

LEAD PIPE, TIN PIPE, SHEET LEAD,
SHEET TIN, RIBBON AND TAPE LEAD,
WHITE LEAD, Dry and in Oil, RED LEAD,
LITHARGE, COPPER AND IRON PUMPS,
SOLDER, PIG LEAD, PIG TIN, ETC., ETC.

☞ **Lead encasing Electric Cables and Wires a Specialty.**

Proprietors of

THE FOREST RIVER LEAD WORKS,

SALEM, MASS.

Correspondence with Water Works solicited.

R. D. Wood & Co.

Engineers,

Iron Founders,

and Machinists.

Office: 400 Chestnut Street, Philadelphia.

FIRE HYDRANT
WITH CRANE ATTACHMENT FOR SPRINKLING CART.

Foundries and Works: Millville, Florence, Camden, N. J.

Constructors of Water and Gas Works.

MANUFACTURERS

—OF—

CAST IRON PIPE

TURBINE WHEELS,

Pumping Machinery,

Hydraulic Cranes,

Lifts and Machinery,

Heavy Loam Castings,

"Eddy" Valves,

"Mathews'" Hydrants.

The American Frost Meter Co.,

OWNING AND CONTROLLING ALL

VERTICAL PISTON METERS.

These Meters are the most DURABLE, ACCURATE, and RELIABLE Meters built — requiring no repairs or attention, and will register accurately on the finest stream. They are the only Meters which received the unqualified approval of the Meter Testing Commission of the city of Boston.

82, 84, 86, 88, & 90 Lenox st., Boston, Mass., U.S.A.

P.O. Box 3659. Write for Circular and Price List.

CHADWICK LEAD WORKS,

Nos. 176, 178, 180, 182, and 184 HIGH STREET (Fort Hill Square),

BOSTON, MASS.,

MANUFACTURERS OF AND DEALERS IN

LEAD PIPE, TIN PIPE, SHEET LEAD,
SHEET TIN, RIBBON AND TAPE LEAD,
WHITE LEAD, Dry and in Oil, RED LEAD,
LITHARGE, COPPER AND IRON PUMPS,
SOLDER, PIG LEAD, PIG TIN, ETC., ETC.

☞ **Lead encasing Electric Cables and Wires a Specialty.**

Proprietors of

THE FOREST RIVER LEAD WORKS,

SALEM, MASS.

Correspondence with Water Works solicited.

Samuel Little, President. William J. Bride, Treasurer.

BOSTON LEAD MANUFACTURING COMPANY,

Corner of Congress and Franklin Sts.,

162 Congress St. BOSTON. 180 and 182 Franklin St.

Manufacturers of

White Lead, Red Lead and Litharge
Patent Tin-Lined Lead Pipe,
Pure Block Tin Pipe.

Lead Pipe and Sheet Lead.

Also Dealers in

Pig Lead, Pig Tin, Solder, Pumps, Etc.

Has an unparalleled Record of more than Fifty Years.

SALES IN THE UNITED STATES, 5,000,000 BARRELS.

"HOFFMAN" ROSENDALE CEMENT.

FROM THE
BEST ROCK.
ADAPTED FOR
Heavy Masonry.
ALWAYS
RELIABLE.

STANDS EVERY
HIGH TEST.
UNIFORM IN
QUALITY
AND
Full Weight.

TAKES THE LEAD OF AMERICAN CEMENTS.

Extensively used by the U.S. Government.

Receives the approbation of the most eminent

ENGINEERS AND ARCHITECTS.

Send for Pamphlet of valuable information to

M. Albert Scull, Ernest R. Ackerman, } General Sales Agents. **LAWRENCE CEMENT CO.,** 67 Williams St., New York.

THOMSON WATER METER

$9.50 5-8 in., $14 3-4 in., $19 1in.

On and after May 1, 1891, the ⅝-in., ¾-in., and 1-in. sizes of the THOMSON METER will be sold to Water-Works Companies and Departments at $9.50, $14, and $19, net, each, respectively.

Nearly 2,900 THOMSON METERS have been sold since January 1, 1891, — a yearly rate of about 9,000; but now we want to make it 18,000!

Our manufacturing facilities have just been increased nearly 50 per cent., and we carry a complete stock of Meters **for Instant Delivery.**

Performance Guaranteed; we Indemnify our Patrons against loss in its use.

A Proved Meter; its Efficiency and Durability thoroughly demonstrated by Time and Severe Duty.

Adopted, Indorsed, and Used by all the prominent Meter Cities, — New York, Providence, Fall River, Fitchburg, Lawrence, Hartford, Rochester, Buffalo, Detroit, Milwaukee, St. Louis, Atlanta, etc., etc.

The only mistake that *you* can make is *not* to get in line.

Thomson Meter Co.

(Sole Makers of the Thomson Water Meter),

211, 212, and 213 Temple Court Building,

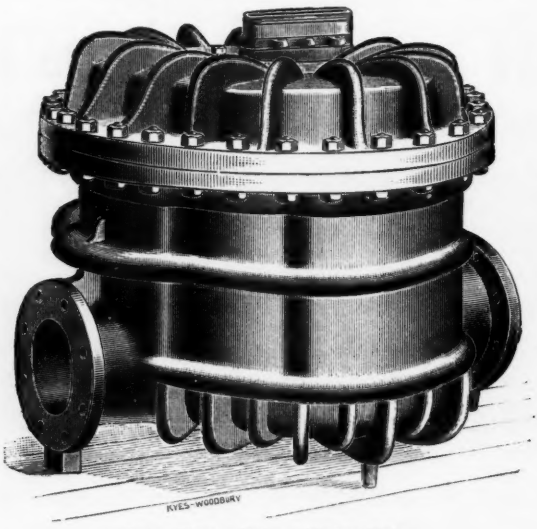
Nassau and Beekman Streets - - - - - - NEW YORK.

UNION WATER METER CO.,

WORCESTER, MASS.

ESTABLISHED IN 1868.

81,000 Made and Sold.



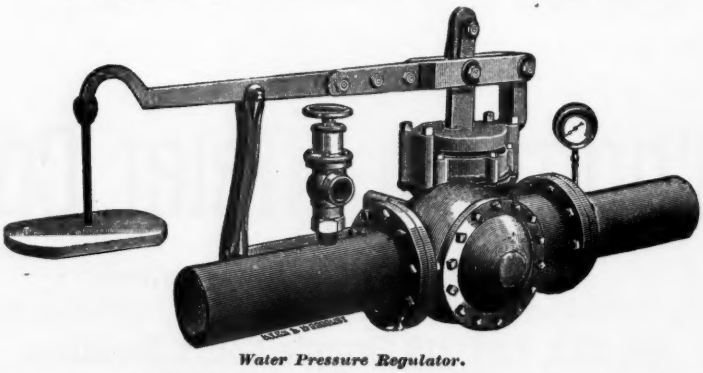
Man'f'rs of the only positive MEASURING 12-in. METERS.

Extra Heavy Rotary Piston Meter.

ROTARY AND RECIPROCATING PISTON

WATER METERS.

Sizes 5-8 inch to 12 inches. Send for Catalogue, etc.

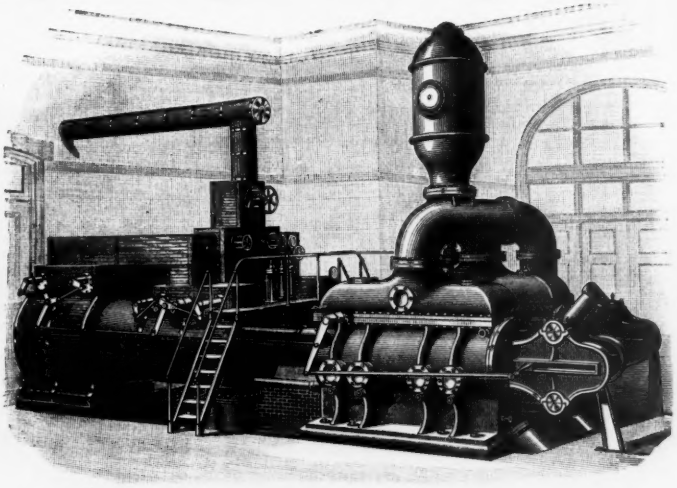


Water Pressure Regulator.

The only positive Automatic Water Pressure Regulator in the market. We have never had a failure.

Write for Lithotype, etc.

THE WORTHINGTON
High Duty Pumping Engine.



DUTY OBTAINED, OVER 110 MILLION FOOT-POUNDS.

HORIZONTAL, VERTICAL, OR BEAM.

Regular Compound

OR **Triple Expansion.**

Lowest First Cost and Maintenance.

HIGHEST ECONOMY.

Total Daily capacity of WORTHINGTON PUMPING ENGINES now in service,

Over 2,000,000,000 Gallons.

An Illustrated Pamphlet descriptive of the Worthington Pumping Engines will be furnished on application to

HENRY R. WORTHINGTON,

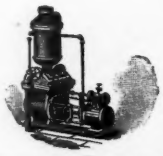
86 and 88 Liberty Street, 145 Broadway,

NEW YORK CITY.

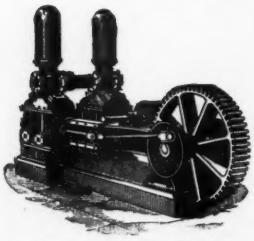
KNOWLES STEAM PUMP WORKS,

BUILDERS OF

PUMPING MACHINERY.



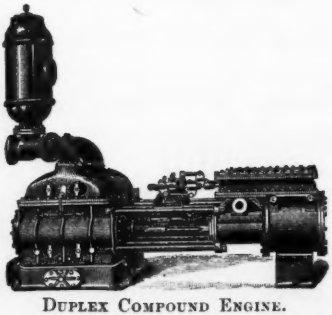
PUMP AND CONDENSER.



GEARED POWER PUMP.

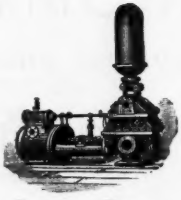
BOILER FEED PUMP.

STEAM AND POWER.

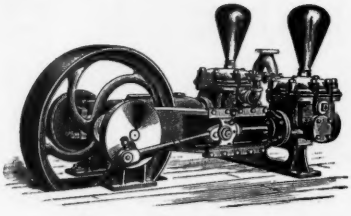


DUPLEX COMPOUND ENGINE.

SINGLE AND DUPLEX.



PRESSURE PUMP.



DUPLEX BELT PUMP.

BOSTON:
111 and 113 FEDERAL STREET.

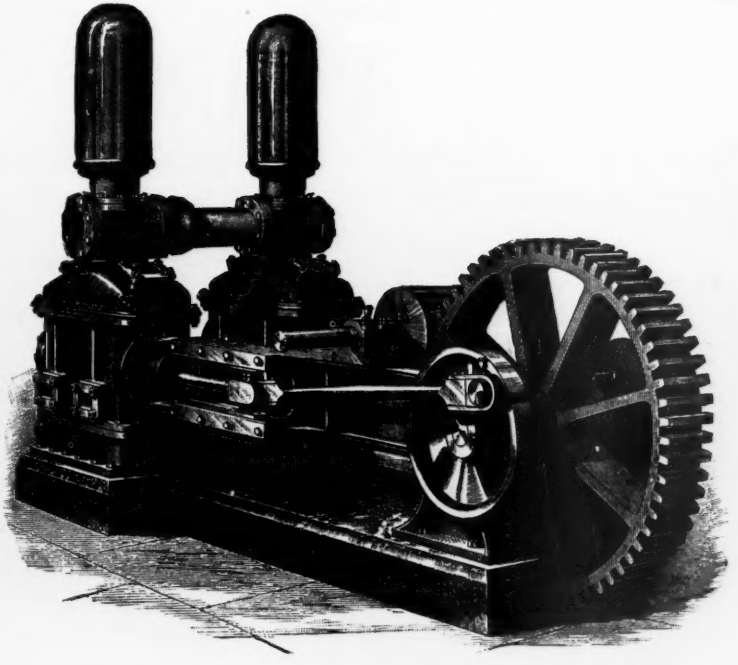
NEW YORK:
93 LIBERTY STREET.

GEO. F. BLAKE MFG. CO.,

BUILDERS OF

STEAM AND POWER

Pumping Machinery



111 and 113 Federal Street,
BOSTON.

95 and 97 Liberty Street,
NEW YORK.

THE

HERSEY WATER METER

GUARANTEED

FOR

FIVE YEARS.

The HERSEY MANUFACTURING COMPANY will make, free of charge, all repairs on their meters, which may be returned to the factory as inefficient from wear or from defective material or construction, for a period of five years from date of purchase.

Experience of the past five years, in manufacturing and selling meters, has demonstrated that the expense of keeping

16,000 HERSEY WATER METERS

in repair is so insignificant that the company is entirely warranted in making the above guarantee.

Trial meters of any size sent to water departments on application.

HERSEY MANUFACTURING CO.,

SOUTH BOSTON, MASS.

ESTABLISHED 1856.

Warren Foundry and Machine Co.

WORKS AT PHILLIPSBURG, NEW JERSEY.

Sales Office, 160 Broadway, New York.

Cast Iron, Water and Gas

PIPE,

From 8 to 48 Inches Diameter.

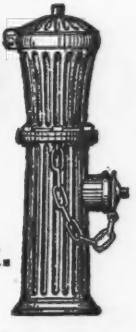
—ALSO—

ALL SIZES OF FLANGED PIPE,

—AND—

SPECIAL CASTINGS.

M. J. Drummond.



Flange Pipe, Lamp Posts,
Stop Valves, Fire Hydrants,
and General Foundry Work.

BUILDERS' IRON FOUNDRY

"Globe" Specials.

Office, Corbin Building, 192 Broadway, New York.

Gloucester Iron Works.

SAMUEL R. SHIPLEY, President. JAMES P. MICHELLON, Secretary.
DAVID S. B. CHEW, Treasurer. WILLIAM SEXTON, Superintendent.

Office, Provident Building, 401 Chestnut Street,

PHILADELPHIA.

Cast-Iron Gas and Water Pipes,

1½, 2, 3, 4, 6, 8, 10, 12, 14, 16, 20, 24, 30, 36, and 48 Inches Diameter.

CAST-IRON FLANGE HEATING AND STEAM PIPES.

2, 3, 3½, 4, 5, 5½, 6, 7, 8, 10, 12, to 48 Inches Diameter.

Fire Hydrants and Stop Valves for Water or Gas, all Sizes.

Loam, Special, and Sugar-House Castings.

ALL PIPE PROVED BY HYDROSTATIC PRESSURE.

GEORGE ORMROD, Manager and Treas., Emaus, Pa.

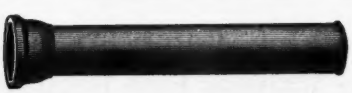
JOHN DONALDSON, President, 136 South Fourth St., Phila., Pa.

EMAUS PIPE FOUNDRY.

DONALDSON IRON CO.,

MANUFACTURERS OF

CAST IRON PIPE,



FOR WATER AND GAS.

ALSO

SPECIAL CASTINGS.

EMAUS, Lehigh Co., Pa.

WE CARRY IN STOCK
AND SELL BY THE PIECE,

Special Castings.

We have one of the best Boiler-Shops in New England,
and make every variety of

Steam Boilers and Tanks.

THE TAUNTON LOCO. MANFG. CO.,

WM. R. BILLINGS, Treas. TAUNTON, MASS.

Globe Special ❋ Castings.

CARRIED IN STOCK.
CHEAPER THAN OLD FORM.

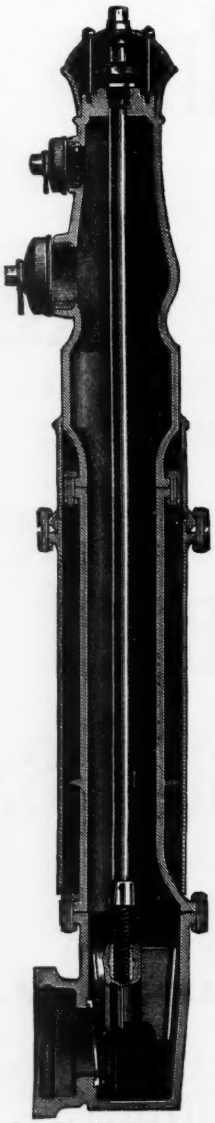
BUILDERS' IRON FOUNDRY,
PROVIDENCE, R.I.

CHAPMAN VALVE MANUFACTURING CO.,

—MANUFACTURERS OF—

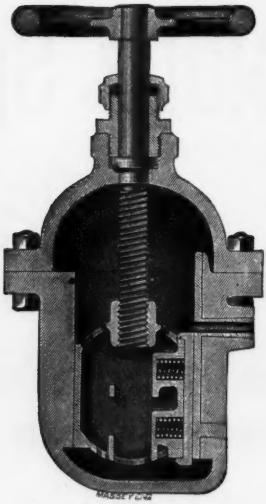
VALVES AND GATES FOR WATER, GAS, STEAM, &C.

GATE FIRE HYDRANTS.



Section Hydrant.

Bell End Water Gate.



Section Drip Valve.

Hydrant.

ALL WORK GUARANTEED.

General Manager's Office and Works, Indian Orchard, Mass.
Treasurer's Office, 72 Kilby Street, Boston.

Walworth Manufacturing Co.,

16 to 20 Oliver Street, Boston, Mass.

FOR WATER WORKS.

Galvanized, Enameled and Plain

IRON PIPES AND FITTINGS,

Gates, Brass and Iron Valves, Cocks, Etc., Etc.

CORPORATION AND STOP COCKS, TOOLS AND SUPPLIES.

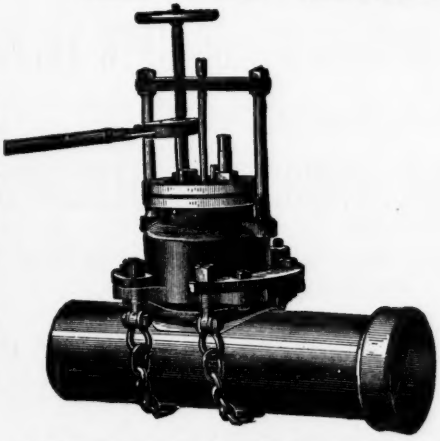
Morgan's Extension Shut-off Boxes (New England Agents).

Miller's Ratchet Pipe Cutting and Threading Tools.

Stillson and Ashley Grip Wrenches.

THE HALL TAPPING MACHINE.

Made of Composition.



Simplest and Best.

For tapping street mains under pressure and inserting service cocks without shutting off water or gas.

We claim for it many advantages over others.

Our one machine does the work usually requiring *two or three.*

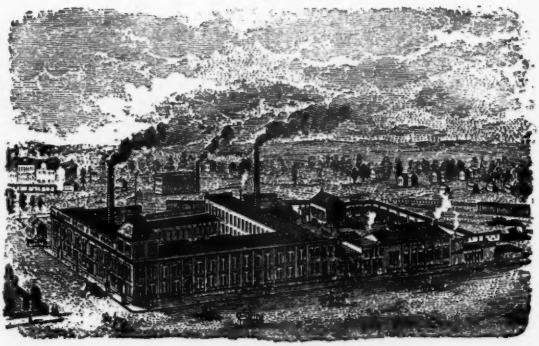
It can be used on mains ranging from *four* to *sixteen* inch (and upwards). Will stand any pressure, and service cocks of almost *any make* may be used; thus its usefulness *is not* limited to the supply of a certain cock. It takes ½ inch, ⅝ inch, ¾ inch, 1 inch, 1¼ inch cocks, and meets any ordinary requirements.

Send for Circular giving Description of its Working Principle, which is Simple and Correct, or Call and Examine it.

WE WARRANT OUR WORK.

GALVIN BRASS AND IRON WORKS,

Office and Works:



Cor. Warren Ave. and 15th St., DETROIT, MICH.

Sole Manufacturers of the

GALVIN PATENT COMPOUND WEDGE GATE VALVES

For Water, Steam, Ammonia, Gas, Oil, Etc.

CONICAL COMPOUND WEDGE GATE HYDRANTS,

Also Improved Compression Fire Hydrants,

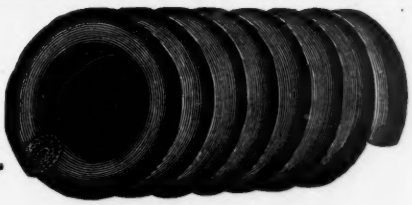
FOOT VALVES, CHECK VALVES, ETC.

General Brass and Iron Goods for

STEAM, WATER AND GAS.

Write for Catalogue and Price List.

RANDOLPH BRANDT,

38  NEW

CORTLANDT ST. YORK.

MANUFACTURERS OF THE

SELDEN PATENT PACKING

(with and without Rubber Core),

For Stuffing-Boxes on Plungers, Piston-Rods, and Valve-Stems.

These packings are made of carefully selected materials, FREE FROM GRIT, and are

SELF-LUBRICATING AND ELASTIC.

The following are a few of the representative houses who use and recommend the Selden Packing: Knowles Steam Pump Works, Pumping Machinery; George F. Blake Mfg. Co., Pumping Machinery; The Jno. H. McGowan Co., Pumping Machinery; Geo. J. Roberts & Co., Pumping Machinery; The Hooven Owens & Rentschler, Hamilton Corliss Engines; The Ritchie & Dyer Co., Stationary and Portable Engines.

C. R. WOODIN, President. WM. F. LOWRY, Treasurer.
C. H. ZEHNDER, Vice-Pres. and Gen. Mgr.
FRED'K H. EATON, Secretary. H. F. GLENN, Gen'l Supt.

THE JACKSON & WOODIN MFG. CO.,

MANUFACTURERS OF

Cast Iron Water and Gas Pipe,

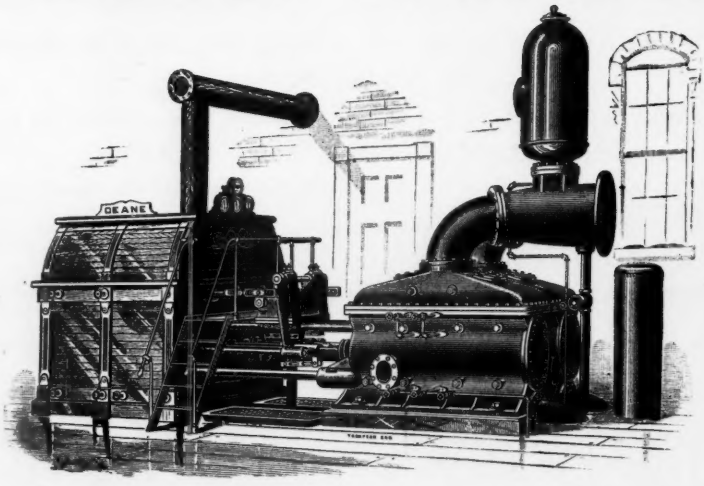
Special Castings, Lamp Posts, Car Wheels, Cars, Merchant Iron and Forgings.

BERWICK, COL. CO., PENNA.

THE DEANE,

OF HOLYOKE,

STEAM PUMPS.



Water-Works Engines.

Daily Pumping Capacity of Deane Water-Works Engines in Service,

Over 325,000,000 Gallons.

For Illustrated Catalogue write

THE DEANE STEAM PUMP CO.,

HOLYOKE, MASS.

New York, Boston, Chicago, Philadelphia,
St. Louis, Denver, Birmingham, Ala.

GET THE BEST.

—THE—

E. Stebbins Mfg. Co.,

Brightwood, P. O., Springfield, Mass.

Manufacturers of

BRASS GOODS FOR WATER WORKS.

ROUGH STOPS.

Corporation Cocks.

Sole Manufacturers of

BROUGHTON'S PATENT SELF CLOSING WORK.

Special attention given to Key Work for Water Works. Send us Samples and get our Quotations.

ALL WORK GUARANTEED.

The New England Water Works Association

was organized in Boston, Mass., on June 21st, 1882, with the object of providing its members with means for social intercourse and for the exchange of knowledge pertaining to the construction and management of water works. From an original membership of only twenty-seven, its growth has prospered until it now includes the names of more than 400 men. Its membership is divided into two principal classes, viz., Active and Associate. The active membership is further divided into two classes, viz., Resident and Non-resident, — the former comprising those residing within the limits of New England, while the latter class include those residing elsewhere. The initiation fee for the former class is five dollars; for the latter, three dollars. The annual dues for both classes of Active membership is two dollars. The Associate membership is open to firms or agents of firms engaged in dealing in water-works supplies. The initiation fee for Associate membership is ten dollars, and the annual dues ten dollars. This Association has four regular meetings each year, also a series of informal monthly meetings, during the winter months, at Boston, Mass.

The Journal of the New England Water Works Association

is a quarterly publication, containing the papers read at the meetings, together with verbatim reports of the discussion. It also contains interesting contributions from writers of the highest standing in their profession. It affords a convenient medium for the interchange of information and experience between its members, who are so widely separated as to find frequent meetings an impossibility. Its success has more than met the expectation of its projectors; there is a large and increasing demand for its issues, and every addition to its subscription list is a material aid in extending its field of usefulness. All members of the Association receive the Journal in return for their annual dues; to all others the subscription is two dollars per annum. If upon inspection of the accompanying copy you feel so inclined, we should be glad to receive your subscription.

The Secretary would be pleased to give further information to any one desiring the same. Address,

R. C. P. COGGESHALL,
Secretary New England Water Works Association,
New Bedford, Mass.